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PROCEEDINGS

31st Ontario Industrial Waste Conference

June 17-20, 1984
The Prince Hotel
Toronto, Ontario

MINISTRY OF THE ENVIRONMENT

CELEBRATING TOGETHER · FÊTONS ÇA ENSEMBLE
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Ontario
Ministry of the Environment

Hon. Andrew S. Brandt
Minister

Brock A. Smith
Deputy Minister

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Proceedings
of the
Thirty-first
Ontario Industrial Waste Conference

held at

The Prince Hotel
Toronto, Ontario

June 17-20, 1984

A Bicentennial Project
Sponsored by the
Ontario Ministry of the Environment

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ONTARIO INDUSTRIAL WASTE CONFERENCE HISTORICAL DATA

Location	Dates	Sponsor
Ontario Agriculture College, Guelph	1954 to 1956	Pollution Control Board of Ontario
Delawana Inn, Honey Harbour	1957 to 1963	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Bigwin Inn, Lake of Bays	1964 & 1965	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Park Motor Hotel, Niagara Falls	1966 & 1967	Ontario Water Resources Commission
Sheraton Brock Hotel, Niagara Falls	1968 to 1971	Ontario Water Resources Commission
Skyline Hotel, Toronto	1972 to 1974	Ontario Ministry of the Environment
The Prince Hotel, Toronto	1975 to 1984	Ontario Ministry of the Environment

Conference Chairman	Dates	Secretary/ Co-Ordinator
Dr. A.E. Berry	1954 to 1962	D.S. Caverly/M. Grove
D.S. Caverly	1963 to 1973	L.M. Tobias
K.H. Sharpe	1974 to 1976	M.J. Cathcart (1974)
D.P. Caplice	1977 & 1978	
	1975 to 1984	M.F. Cheetham
J.W. Giles	1979 to 1984	

Program Conveners

1960-1973	F.A. Voege
1974-1978	J.B. Patterson
1979-1984	R.C. Stewart

PREFACE TO THE PROCEEDINGS OF THE 31st ONTARIO INDUSTRIAL WASTE CONFERENCE

The 31st Ontario Industrial Waste Conference has concluded with a most creditable attendance of delegates and spouses totalling 552. As an Ontario Bicentennial project under the sponsorship of the Ministry of the Environment, the presence of guest speakers from Sweden, England and the United States added a distinction to the program which was appreciated by all attending.

Unfortunately your chairman was not able to attend the Conference this year because I was out of the country on Ontario Government business. I would like to thank the Vice-Chairman, Ron Gotts, for stepping in at the last minute to perform my duties in such a commendable manner. I would also like to thank the other members of the Conference Planning Committee and the Program Committee for their usual fine contribution to the overall success of the Conference. Without this, we would not continue to attract such a high registration of delegates and spouses, and stage an event that has become an annual "must" for those interested in environmental management.

This year the nineteen papers that were presented at the Conference maintained the high calibre of preparation and presentation that has become the hallmark of our annual event. The session chairmen, the authors and those who assisted them in the preparation of their papers, and all others who participated in the development and delivery of the program, are to be commended. Even with all the concern, last minute changes and program adjustments, the Conference attained its objective of presenting timely and debatable subjects in keeping with the overall theme. Our appreciation to all who co-operatively helped to achieve this goal.

On behalf of the Ministry, thank you for registering for the 31st Conference. The following copy of the Proceedings of the Conference will give you a permanent record of the papers presented, the ideas promulgated, and hopefully, will afford the opportunity to review and discuss with others the environmental thoughts and actions which are offered by the authors.

The 32nd Ontario Industrial Waste Conference is planned for June 16-19, 1985 at the Prince Hotel in Toronto. You and your associates are invited to attend.

J. Walter Giles
Conference Chairman

CONFERENCE PLANNING COMMITTEE

Conference Chairman
J.W. Giles
Associate Deputy Minister
Intergovernmental Relations and
Strategic Projects
Ontario Ministry of the Environment

Conference Vice-Chairman
R.M. Gotts
Director, Waste Management
Branch, Ontario Ministry
of the Environment

Program Convener
R.C. Stewart
Manager Technical Support
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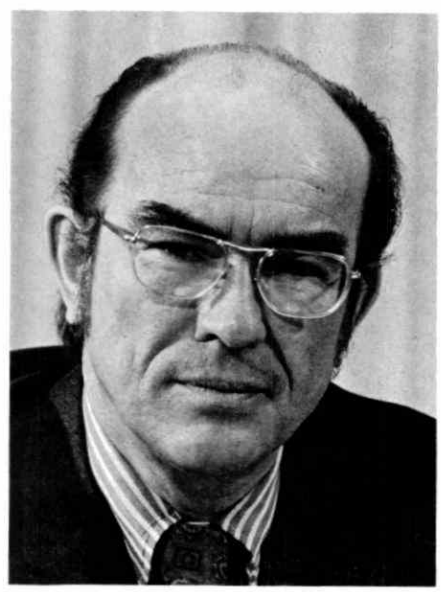
Ontario Ministry of the Environment



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M.F. Cheetham
Public Affairs Co-Ordinator
Communications Branch,
Ontario Ministry of the Environment

TECHNICAL PROGRAM COMMITTEE

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Industrial Approvals Section
Environmental Approvals and Project
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B. Boyko, Director,
West Central Region,
Environment Ontario, Hamilton

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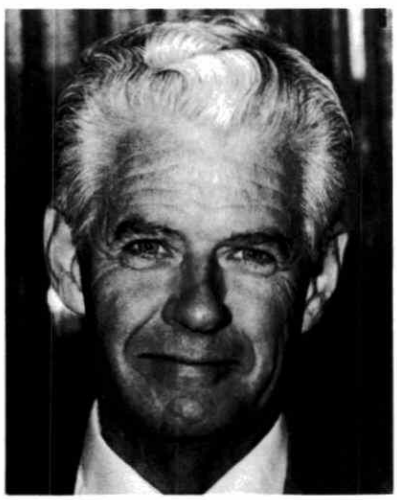
and Reg. Development Section
Air Resources Branch,
Environment Ontario



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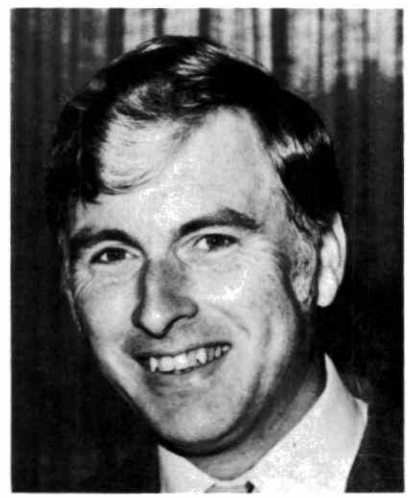

J. Hawley, Head Mining, Metallurgy &
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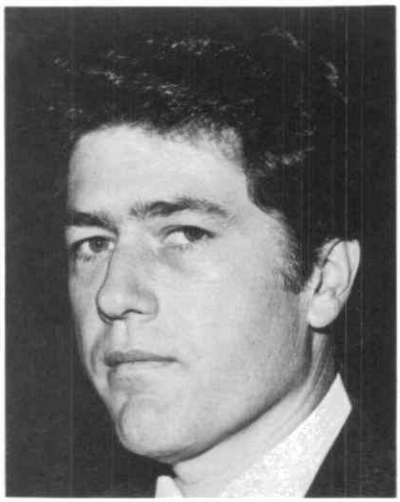
SESSION I – INTERNATIONAL PERSPECTIVES

Chairman: R.M. Gotts
Director, Waste Management
Branch, Environment Ontario
Toronto, Ontario

The Honourable Andrew S. Brandt
Ontario Minister of the Environment
Toronto, Ontario



John H. Skinner, Director,
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Washington, D.C.

C.J. Macfarlane,
Environmental Consultant
Ontario Industrial Corporation
Ministry of Industry & Trade
Toronto, Ontario

CANADIAN PERSPECTIVES

by
The Honourable Andrew S. Brandt
Ontario Minister of the Environment

IT IS INDEED A PLEASURE TO BE HERE TODAY AND TO WELCOME YOU TO THE 31ST ONTARIO INDUSTRIAL WASTE CONFERENCE. THIS YEAR'S CONFERENCE HAS BEEN DESIGNATED AS AN ONTARIO BICENTENNIAL PROJECT OF THE MINISTRY OF THE ENVIRONMENT - A PROJECT, I'M SURE, THAT WELL MERITS ITS OFFICIAL DESIGNATION.

AS WE CELEBRATE ONTARIO'S 200TH ANNIVERSARY, TWO CENTURIES OF RESIDENTIAL AND INDUSTRIAL GROWTH ARE BEING BROUGHT INTO FOCUS. IT IS IMPORTANT TO NOTE THAT WE HAVE ACHIEVED OUR GROWTH WHILE MAINTAINING WATER, LAND AND AIR THAT IS AMONG THE CLEANEST IN THE INDUSTRIALIZED WORLD. AND WE INTEND TO CONTINUE OUR EFFORTS TO MAKE OUR ENVIRONMENT EVEN BETTER.

WE ARE HERE TODAY FOR THIS VERY REASON. OUR CONFERENCE IS INTENDED TO PROVIDE A FORUM FOR CONSTRUCTIVE REVIEW OF OUR PROGRESS AND, MORE IMPORTANTLY, A PERSPECTIVE ON THE FUTURE.

WE IN ONTARIO APPRECIATE THE QUALITY OF OUR ENVIRONMENT, AND OUR COMMON GOAL IS THE MAINTENANCE AND PRESERVATION OF THIS NATURAL WEALTH AND QUALITY. BUT OUR COMMITMENT ALONE SOMETIMES IS NOT ENOUGH.

WE MUST LOOK TO OTHER JURISDICTIONS -- BOTH NATIONAL AND INTERNATIONAL -- FOR SIMILAR COMMITMENT AND FOR CO-OPERATION AND SUPPORT IN DEALING WITH ENVIRONMENTAL ISSUES.

SINCE MY APPOINTMENT ABOUT ONE YEAR AGO, I HAVE PARTICIPATED IN A NUMBER OF NATIONAL AND INTERNATIONAL ACTIVITIES DEDICATED TO CO-OPERATIVELY MEETING THE ENVIRONMENTAL CHALLENGES OF THE 80S.

TODAY I INTEND TO SHARE WITH YOU SOME OF MY THOUGHTS ON THE PAST YEAR, TO BRING YOU UP-TO-DATE ON THE WORK OF MY MINISTRY AND TO OUTLINE FOR YOU OUR PLANS FOR THE FUTURE.

IN DOING SO I WANT TO FOCUS ON MY MINISTRY'S LONG TERM PLAN FOR ESTABLISHING AN EFFICIENT AND MODERN SYSTEM OF DEALING WITH WASTE IN THIS PROVINCE.

MOE ACTIVITIES

BEFORE DEALING WITH THE BLUEPRINT, HOWEVER, I WILL BRIEFLY REVIEW SEVERAL WASTE MANAGEMENT AND ENVIRONMENTAL PROTECTION INITIATIVES, WITH BOTH NATIONAL AND INTERNATIONAL RAMIFICATIONS, WHICH MY MINISTRY HAS RECENTLY UNDERTAKEN.

1) MOBILE PCB DESTRUCTION FACILITIES

FOR MANY YEARS NOW, PCBS HAVE BEEN A SOURCE OF CONSIDERABLE PUBLIC CONCERN. SOME SIX MILLION LITRES OF PCB ARE CURRENTLY IN USE AND AN ADDITIONAL 1.5 MILLION LITRES ARE IN STORAGE - AWAITING SAFE DESTRUCTION.

WHILE OUR EXISTING LEGISLATION AND REGULATORY STRUCTURE MAKES PROVISIONS TO APPROVE FIXED PCB DESTRUCTION FACILITIES - NO SUCH FACILITIES EXIST IN THE PROVINCE OR IN CANADA.

IN MAY I ANNOUNCED MY MINISTRY'S PROPOSALS FOR THE REGULATION AND CONTROL OF MOBILE PCB DESTRUCTION FACILITIES.

I HOPE BY YEAR-END TO SEE OUR REGULATORY PROPOSALS FINALIZED. THEN PRIVATE SECTOR PROPONENTS SHOULD BE IN A POSITION TO PROCEED WITH PROGRAMS FOR THE EFFICIENT USE OF MOBILE FACILITIES.

2) A NEW IMPROVEMENT TEAM

ANOTHER RECENT INITIATIVE OF MY MINISTRY IS THE FORMATION OF THE DETROIT/ST. CLAIR/ST. MARYS RIVERS IMPROVEMENT TEAM, WHICH WILL CO-ORDINATE AND HARMONIZE OUR MANY ENVIRONMENTAL PROTECTION EFFORTS RELATED TO THE DETROIT/ST. CLAIR AND ST. MARYS RIVERS AND LAKE ST. CLAIR.

OUR NIAGARA RIVER TEAM, ESTABLISHED IN 1981, HAS MONITORED INDUSTRIAL AND MUNICIPAL CONTAMINANT SOURCES IN ONTARIO AND, THROUGH CO-OPERATIVE ARRANGEMENTS WITH U.S. FEDERAL AND STATE AUTHORITIES, IT HAS KEPT CLOSE WATCH ON CLEANUP ACTIVITIES AND PREVENTIVE MEASURES REQUIRED IN THE EXTENSIVE WASTE SITES ON THE U.S. SIDE OF THE RIVER.

THE DETROIT/ST. CLAIR/ST. MARYS RIVERS IMPROVEMENT TEAM WILL BRING A NEW AND SHARPER FOCUS TO OUR ACTIVITIES IN THIS PART OF ONTARIO.

3) ADVISORY COMMITTEE ON DIOXINS AND FURANS

AN ONTARIO SCIENTIFIC ADVISORY COMMITTEE ON DIOXINS AND FURANS HAS BEEN ESTABLISHED TO DEVELOP NEW ENVIRONMENTAL OBJECTIVES FOR THESE SUBSTANCES. WE HAVE BEEN FORTUNATE IN BEING ABLE TO RECRUIT A BLUE-RIBBON PANEL OF INTERNATIONALLY-ACKNOWLEDGED AUTHORITIES IN THE FIELD.

4) FEDERAL/PROVINCIAL WORKING GROUP

MY MINISTRY PARTICIPATES ACTIVELY ON THE FEDERAL-PROVINCIAL WORKING GROUP ON DRINKING WATER QUALITY, WHICH HAS RECONVENED TO CONSIDER REVISIONS AND ADDITIONS TO THE GUIDELINES FOR CANADIAN DRINKING WATER QUALITY. SUCH DELIBERATIONS MAY FORM THE BASIS FOR SUBSEQUENT REVISIONS TO FEDERAL AND PROVINCIAL OBJECTIVES.

BLUEPRINT

SOME OF YOU WERE HERE LAST YEAR WHEN MY PREDECESSOR, KEITH NORTON RELEASED THE "BLUEPRINT FOR WASTE MANAGEMENT IN ONTARIO". THE 75-PAGE BLUEPRINT, WITH ITS 11 APPENDICES, SET OUT A COMPREHENSIVE SERIES OF MINISTRY PROPOSALS AND OPTIONS, INCLUDING PROPOSED CONTROLS AND REGULATIONS WHICH COVER THE FULL SPECTRUM OF WASTE MANAGEMENT FROM GENERATION THROUGH RECYCLING TO POST-DISPOSAL ENVIRONMENTAL SECURITY.

SINCE THAT TIME, EXTENSIVE PUBLIC DIALOGUE HAS TAKEN PLACE.

- CITIZENS, MUNICIPAL COUNCILS AND STAFF, AND SOCIAL AND INDUSTRIAL ORGANIZATIONS ATTENDED 139 PUBLIC INFORMATION SESSIONS, FORUMS, WORKSHOPS AND MEETINGS ON THE BLUEPRINT.

- 1,100 REPRESENTATIVES OF CONCERNED GROUPS, MUNICIPALITIES AND INDUSTRIES ATTENDED THE 20 PUBLIC FORUMS HELD ACROSS ONTARIO TO PROVIDE COMMENT.

- MORE THAN 250 FORMAL SUBMISSIONS WERE MADE TO ENVIRONMENT ONTARIO.

WE HAVE A WEALTH OF CONSTRUCTIVE INFORMATION AND COMMENT AND WE ARE LOOKING CAREFULLY AT ALL OF IT IN PLANNING THE PATH ONTARIO WILL FOLLOW IN WASTE MANAGEMENT FROM THIS POINT INTO THE 21ST CENTURY.

I AM PLEASED NOW TO REPORT OUR PROGRESS DOWN THIS PATH. IN A NUMBER OF AREAS, WE FOUND STRONG, WIDE SPREAD SUPPORT AND THESE PROGRAMS ARE CLOSE TO DELIVERY.

INDUSTRIAL WASTES

WE HAVE DRAFTED CHANGES TO OUR REGULATIONS WHICH WILL PERMIT THE MANDATORY REGISTRATION OF HAZARDOUS AND LIQUID INDUSTRIAL WASTE GENERATORS. THOSE COMPANIES WHOSE PROCESSES PRODUCE THESE WASTES WILL BE REQUIRED TO REGISTER THEMSELVES AND THEIR WASTES WITH MY MINISTRY.

THE EXISTING WAYBILL SYSTEM IS BEING IMPROVED AND EXPANDED TO INCLUDE SOLID HAZARDOUS WASTES AND TO PLACE THE PRIME RESPONSIBILITY FOR TRACKING WASTES WITH THE WASTE GENERATOR. A NEW COMPUTER SYSTEM HAS BEEN PURCHASED TO MANAGE THIS INCREASED DATA BASE. WE EXPECT THESE IMPROVED CONTROLS TO GO INTO EFFECT THIS FALL.

WHILE NEW DEFINITIONS WILL BE INCORPORATED INTO THE REGULATIONS TO COMPLEMENT THESE REQUIREMENTS, THE SITE-SPECIFIC WASTE DEFINITION PROPOSED IN THE BLUEPRINT IS STILL UNDER REVIEW. IN FACT, WE ARE REVIEWING THE WHOLE APPROACH TO THE CO-DISPOSAL OF CERTAIN INDUSTRIAL WASTES IN MUNICIPAL LANDFILLS AND THE DISPOSAL OF THESE WASTES IN CERTAIN INDUSTRIAL SITES THROUGH SITE-SPECIFIC DEFINITION.

DURING THIS CONTINUING REVIEW, THESE SOLID INDUSTRIAL WASTES WILL HAVE TO MEET NOTIFICATION CONTROL REQUIREMENTS INCLUDED IN THE PROPOSED GENERATOR REQUIREMENTS. IN SOME CASES, THESE WASTES WILL REQUIRE THE SAME MANAGEMENT AS HAZARDOUS WASTES.

FILLING GAPS

MY STAFF HAS DRAFTED GUIDELINES TO CLARIFY AND FILL IN GAPS IN THE WASTE MANAGEMENT AREAS. THESE INCLUDE SLUDGE USE ON LAND, THE USE OF LAND ADJACENT TO LANDFILLS AND THE DISPOSAL OF SLUDGE IN LANDFILLS.

WE HAVE COMPLETED A COMPUTER INVENTORY OF ALL ACTIVE WASTE DISPOSAL SITES. A SIMILAR INVENTORY OF CLOSED LANDFILL SITES IS CURRENTLY NEARING COMPLETION AND, IN THE NEAR FUTURE, WE WILL HAVE A COMPUTER INVENTORY OF ALL PATHOLOGICAL WASTE INCINERATORS.

FOR SOME OTHER PROGRAMS OUTLINED IN THE BLUEPRINT, WE RECEIVED CONSIDERABLE GENERAL SUPPORT AND, WHILE I CANNOT FIX A DELIVERY DATE, WE HAVE DETERMINED A CLEAR DIRECTION.

REGULATION 309

OUR PRIMARY WASTE MANAGEMENT REGULATION, REGULATION 309, IS BEING REWRITTEN TO PROVIDE SOME FLEXIBILITY IN RESPONSE TO A GENERAL CONCERN OF THOSE WHO RESPONDED TO THE BLUEPRINT. THERE IS SUBSTANTIAL AGREEMENT THAT STANDARDS FOR THE OPERATION AND MAINTENANCE OF LANDFILL SITES, AND INDEED ALL WASTE MANAGEMENT FACILITIES IN THE PROVINCE SHOULD RECOGNIZE AND ACCOMMODATE DIFFERENCES IN GEOGRAPHY, SIZE OF OPERATION AND SIZE AND RESOURCES OF THE COMMUNITIES SERVED.

WE AGREE THAT TOTAL UNIFORMITY IS UNREALISTIC AND WE ARE DRAFTING A SITE CLASSIFICATION SYSTEM WHICH WILL PROVIDE A BETTER APPROACH.

IMPROVED STANDARDS FOR HAZARDOUS AND LIQUID INDUSTRIAL WASTE CARRIERS ARE ALSO BEING PREPARED FOR INCLUSION IN REGULATION 309. THESE WILL ADDRESS, AMONG OTHER THINGS, DRIVER TRAINING AND FINANCIAL SECURITY. AT THE SAME TIME, WE ARE WORKING ON NEW CONTROL APPROACHES FOR WASTES USED FOR DUST SUPPRESSION AND FOR FILL MATERIAL AT CONSTRUCTION SITES. A NUMBER OF GUIDELINES WHICH COMPLEMENT THE REVISED REGULATION ARE NOW IN DRAFT STAGE.

RESPONSIBILITY

A GREAT DEAL OF BLUEPRINT DISCUSSION REVOLVED AROUND THE RESPONSIBILITIES AND AUTHORITY OF THE VARIOUS PLAYERS IN WASTE MANAGEMENT. THE ROLES OF THE PROVINCE, REGIONAL AND MUNICIPAL GOVERNMENT AND INDUSTRY WERE ADDRESSED AT LENGTH. I HAVE ALREADY MENTIONED SOME INITIATIVES IN OUR REGULATIONS DEALING WITH PROVINCIAL AUTHORITY AND CLARIFYING SOME INDUSTRIAL RESPONSIBILITIES.

MY STAFF IS WORKING VERY CLOSELY WITH THE MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING TO DRAFT CHANGES TO THE MUNICIPAL ACT AND THE REGIONAL GOVERNMENT AND RESTRUCTURED COUNTIES ACTS TO DEFINE CLEARLY THE AUTHORITY AND RESPONSIBILITIES OF UPPER AND LOWER TIER MUNICIPALITIES IN THE WASTE MANAGEMENT FIELD.

THE FOUR RS

ONE OF THE MAJOR AREAS OF PROGRESS IN WASTE MANAGEMENT TODAY IS IN THE FOUR RS -- REDUCTION, REUSE, RECLAMATION AND RECYCLING OF WASTES. I AM SEEING A GENUINE CO-OPERATIVE EFFORT INVOLVING THE PUBLIC INTEREST GROUPS, MUNICIPALITIES, THE WASTE MANAGEMENT INDUSTRY, THE INDUSTRIAL SECTOR WHICH PROVIDES MARKETS FOR MATERIALS AND MY MINISTRY'S RESOURCES.

STATISTICS DERIVED FROM OUR EXISTING WAYBILL SYSTEM INDICATE THAT THE QUANTITY OF LIQUID INDUSTRIAL WASTE DESTINED FOR RECYCLING OR REUSE HAS INCREASED SUBSTANTIALLY OVER THE PAST FEW YEARS.

MAJOR COMPANIES IN ONTARIO ARE ACTIVELY INVOLVED IN RECYCLING OR REUSE OF INDUSTRIAL WASTES.

OUT OF 72 MILLION GALLONS OF LIQUID INDUSTRIAL WASTE TRACKED IN 1983, OVER 13 MILLION GALLONS (OR 18 PER CENT) WERE RECYCLED. THIS IS AN INCREASE OF ALMOST 90 PER CENT OVER 1980 STATISTICS. WHILE BETTER ACCOUNTING IS A FACTOR IN THIS RECORDED INCREASE, THE QUANTITY OF LIQUID INDUSTRIAL WASTE BEING RECYCLED OR REUSED IS MUCH GREATER.

CLEARLY, RECYCLING AND REUSE PROGRAMS ARE AN INCREASING PART OF EFFECTIVE WASTE MANAGEMENT IN THE INDUSTRIAL SECTOR.

MOVING FROM THE INDUSTRIAL TO THE MUNICIPAL LEVEL, WE ARE REVIEWING A REQUEST FOR FUNDING FROM THE LONDON VICTORIA HOSPITAL ENERGY FROM WASTE PROJECT WHICH HAS BEEN APPROVED AFTER A COMPREHENSIVE ENVIRONMENTAL ASSESSMENT BOARD HEARING. THIS PROJECT HAS THE POTENTIAL TO BECOME ONTARIO'S STATE-OF-THE-ART ENERGY FROM WASTE FACILITY, ADDING DEPTH TO OUR FOUR RS INITIATIVES IN TERMS OF WASTE RECOVERY.

My Ministry and the Ministry of Energy are now receiving letters of qualifications from consultants for a major strategy study with respect to energy from waste, materials recovery and the four Rs in general. Our objective is to develop and propose to Cabinet a new program to ensure that any barriers to EFW and the four Rs are known and addressed by policy.

While policy development continues, there is continuing progress, especially in recycling initiatives.

My Ministry has been actively encouraging recycling in Ontario communities. To date we have provided close to $1 million in seed money to help establish and promote 10 source separation operations serving 15 municipalities. We will continue to provide leadership and encourage these initiatives.

They are proving their effectiveness. Kitchener and Halton are reporting a 70 per cent participation rate in the programs. In addition, they are diverting about 10 per cent of their solid waste into recycling.

THE RECYCLING SUPPORT COUNCIL, WHICH IS A COALITION OF INDUSTRIAL AND PUBLIC INTEREST REPRESENTATIVES, HAS BECOME AN ACTIVE AGENT IN RECYCLING WITH PROJECTS LIKE THE YOUTH VENTURES PROGRAM IN DOWNTOWN TORONTO.

THE CANADIAN TINPLATE RECYCLING COUNCIL IS NEWER TO THE FIELD BUT HAS AN AMBITIOUS IN-HOUSE RECYCLING PROGRAM AT STELCO AND HAS BEEN APPROACHING A NUMBER OF GROUPS INTERESTED IN RECYCLING.

THE FINE PAPER RECYCLING PROGRAM WE PIONEERED IN THE ONTARIO GOVERNMENT HAS BEEN A CONSISTENT PERFORMER WITH 14,200 CIVIL SERVANTS IN THE METRO AREA ONTARIO GOVERNMENT BUILDINGS AVERAGING BETWEEN 40 AND 50 POUNDS EACH A YEAR RECYCLING OFFICE PAPER.

ADD TO THIS THE INCREASING NUMBER OF MUNICIPAL AND PRIVATE SECTOR OFFICE BUILDINGS THAT HAVE STARTED RECYCLING FINE PAPER FROM PETERBOROUGH IN THE EAST THROUGH HAMILTON, NIAGARA AND LONDON AND YOU CAN SEE A VERY HEALTHY EFFORT.

THE KEY FACTOR IN ALL OF THIS IS A GENUINE CO-OPERATIVE EFFORT ON THE PART OF MUNICIPALITIES, ENVIRONMENTAL GROUPS, WASTE MANAGEMENT CONTRACTORS, INDUSTRIAL MARKETS AND MY MINISTRY.

PERPETUAL CARE

ONE OF THE MOST COMPLEX ISSUES WHICH REMAINS TO BE RESOLVED IS PERPETUAL CARE. THERE IS CONSENSUS THAT WASTES, ONCE DISPOSED SHOULD NOT BE ALLOWED TO CAUSE PROBLEMS IN THE FUTURE AND THAT SECURITY IS NEEDED TO ENSURE REMEDIAL ACTION AND COMPENSATION IF PROBLEMS EMERGE.

IN FACT WE NOW REQUIRE FINANCIAL GUARANTEES ON SOME SITES. HOWEVER, THERE IS WIDESPREAD DISAGREEMENT ON THE NATURE AND FORM OF A PERPETUAL CARE PROGRAM, THE EXTENT OF SECURITIES REQUIRED AND, OF COURSE, THE MATTER OF WHO SHOULD PAY.

THIS IS CLEARLY AN ISSUE WHICH REQUIRES FURTHER STUDY AND REVIEW AND FURTHER PUBLIC CONSULTATION.

PLANNING AND APPROVALS

THE STREAMLINING OF THE APPROVALS PROCESS AND THE ENVIRONMENTAL ASSESSMENT PROCESS ARE AREAS OF OBVIOUS CONCERN TO MANY PARTIES. WHILE THIS IS NOT RESTRICTED TO THE BLUEPRINT, WE CERTAINLY HEARD A LOT ABOUT IT IN THAT PROCESS.

AS MANY OF YOU KNOW, ASIDE FROM REVIEWING THE CURRENT PROCEDURES AND REGULATIONS, WE ARE ASSISTING IN AT LEAST TWO IMPORTANT EXPERIMENTS IN THIS AREA.

WE ARE FUNDING THE REGION OF WATERLOO MASTER PLAN FOR WASTE MANAGEMENT THROUGH THE ENVIRONMENTAL ASSESSMENT PROCESS. IF THIS PROVES TO BE A SUCCESSFUL APPROACH AND RESULTS IN FEWER OR SIMPLER SUBSEQUENT HEARINGS FOR SPECIFIC DEVELOPMENTS, THEN IT MAY BE A MODEL FOR OTHER JURISDICTIONS.

WE ARE ALSO FUNDING A MEDIATOR THROUGH THE ENVIRONMENTAL ASSESSMENT BOARD TO WORK WITH THE NORTH SIMCOE LANDFILL COMMITTEE IN AN EFFORT TO FOCUS ON THE MAIN ISSUES IN LOCATING A NEW LANDFILL SITE IN THAT AREA.

IN A MORE DIRECT WASTE PLANNING INITIATIVE, THE MINISTRY HAS SET UP A PROVINCIAL TASK FORCE TO DEVELOP A LONG RANGE STRATEGY FOR THE PROPER AND SAFE MANAGEMENT OF PATHOLOGICAL WASTES IN THIS PROVINCE.

CONCLUSION

WASTE MANAGEMENT IS A MOST PRESSING ENVIRONMENTAL CHALLENGE FOR THE '80S. MY GOAL AND MY MINISTRY'S GOAL IS TO SUCCESSFULLY MEET THIS CHALLENGE, THROUGH THE PROPER CONTROL OF INDUSTRIAL WASTES AND THE IMPLEMENTATION OF A COMPREHENSIVE WASTE MANAGEMENT PROGRAM FOR ONTARIO.

WE ARE CONTINUING TO DEVELOP THE PROGRAMS WHICH WE INITIATED UNDER THE UMBRELLA OF THE BLUEPRINT FOR WASTE MANAGEMENT. AS SPECIFIC PROPOSALS ARE BROUGHT FORWARD BY MY MINISTRY WE WILL CONTINUE TO SEEK INPUT FROM THOSE CONCERNED -- OUR MUNICIPALITIES, THE WASTE MANAGEMENT INDUSTRY, THE GENERATORS OF WASTE AND THE ENVIRONMENTAL COMMUNITY. AND WE WILL KEEP THE GENERAL PUBLIC INFORMED OF OUR PROGRAMS.

WASTE MANAGEMENT IS A CHALLENGE FOR TODAY YET AN OPPORTUNITY FOR THE FUTURE, NOT ONLY FOR GOVERNMENT, BUT FOR EACH AND EVERY ONE OF US.

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UNITED STATES PERSPECTIVES

by
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EPA administers hazardous waste management programs under both the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). These are the Agency's top priority programs, and I will discuss activities under both statutes.

The next few years will see significant changes to the Agency's hazardous waste program. Congress is expected to reauthorize RCRA during 1984 and CERCLA is expected to be reauthorized in 1985. This will provide the opportunity to complete regulatory activities and will set new directions for the long-term implementation of both the RCRA and CERCLA programs. We will see a reexamination of the roles of all participants in the hazardous waste programs to take advantage of the opportunities for new partnerships among the States, EPA, local governments, the regulated commmunity, and Congress.

Authorization of States to firmly place them in the implementing role and delegation of responsibilities from Headquarters to the Regions are fundamental principles of both programs. In order to successfully carry out this authorization and delegation process, effective communication and coordination among all participants, and accountability will be vital.

There will be an expansion of the scope of the RCRA and CERCLA programs throughout 1985 and 1986. New hazardous wastes will be listed, new sites requiring cleanup will be identified, the size of the community to be regulated will be increased, and new technologies will be developed and employed.

PROGRAMS UNDER CERCLA (SUPERFUND)

The overall strategy for CERCLA has three major elements. First is completion of the identification and assessment of uncontrolled hazardous waste sites in the current Agency inventory. Second is the stabilization of those sites which present an imminent threat to public health or the environment. Third is dealing with those sites that should receive priority attention for remedial clean-up action.

Site Identification And Assessment

Our program to compile the best available data on the scope of the uncontrolled hazardous waste problem uses three systems: the Emergency and Remedial Information System (ERRIS),

the Hazardous Ranking System (HRS), and the National Priority List (NPL).

ERRIS is our self-reporting hazardous site notification and inventory system. ERRIS includes a listing of all facilities which have reportedly accepted hazardous substances for transport, storage, treatment, or disposal or situations where hazardous substances have been either accidentally or illegally spilled or dumped. ERRIS currently contains more than 17,000 sites. A major effort that is adding to this total is under way using $10 million in grant funds provided under Section 3012 of Superfund. Using these funds, the states are carrying out additional site discovery, assessment and inspection work. Eventually, we expect ERRIS to contain some 22,000 sites.

The Hazardous Ranking System was developed to determine national priorities among releases or threatened releases of hazardous substances. HRS quantifies the hazard at the sites and estimates relative potential danger from the release or threatened release of hazardous substances. Presently, nearly 900 sites have been evaluated and "scored". These 900 sites were submitted by the states as candidates for the National Priorities List and hence remedial action under Superfund.

To date, there are 546 individual sites on the proposed and final National Priorities List. These are the sites deemed to be serious enough to require remedial action. Currently, NPL sites are the only ones eligible for remedial action using funds under the $1.6 billion Superfund trust.

Stabilization of Sites Through Removal Actions

Removal actions are authorized by Superfund to address immediate problems where releases or threatened releases pose danger to public health. In 1983, EPA conducted 100 emergency removals, eight planned removals, and provided on-scene assistance to state, local or other responsible parties at 400 hazardous substance release incidents.

The Agency's highest priority is to stabilize imminent threats at NPL sites and to immediately limit the threat presented to the public.

The Agency will conduct a Superfund-financed removal action in those situations where timely action by a potentially responsible party is not expected or the response is beyond the independent financial or technical capabilities of state and local agencies. In the removal enforcement program there will be two principal emphases: aggressive and early pursuit of responsible party action wherever feasible, and cost recovery for those removals financed by the Fund.

Where an extreme emergency situation does not exist and responsible parties have not undertaken the removal action, EPA will seek to issue a unilateral Section 106 administrative order before EPA initiates removal action. The Agency has found these orders to be very effective in getting responsible parties to assume the responsibility for cleanup. Issuance of these orders also establishes the Agency's claim to seek treble damages from responsible parties who do not comply using Section 107.

Where the responsible party is not economically viable or is unwilling to undertake action, Fund-financed action may be taken. If responsible parties prove unwilling to enter into negotiations, or in the course of negotiations prove unwilling to carry out the removal action, a unilateral administrative order will be issued. If there is non-compliance with any order a Fund-financed removal will be undertaken and cost recovery (including treble damages) will be pursued.

Criminal sanctions will be pursued under Section 103(b)(3) of CERCLA against persons who fail to report releases of reportable quantities of hazardous substances in aggravated cases. Factors to be considered in selecting these cases will include the actual or potential environmental harm resulting from the release; the impact of non-notification on the Agency's ability to implement an effective response; efforts by the individual to conceal the occurrence of the release; and independent efforts made by the individual to identify and implement responsive action.

The Remedial Program

The National Contingency Plan (NCP) contains instructions for systematic implementation of the remedial program. Revisions to the NCP will be proposed in Fiscal Year 1984 to: (1) streamline procedures and eliminate unnecessary steps in the process of site cleanup, (2) specify procedures for public involvement in the selection of remedies, (3) allow addition of Federal facilities to the National Priorities List (NPL) and, (4) identify a more definitive process to determine "how clean is clean."

Litigation to recover fund expenditures will emphasize removal costs. Efforts to recover remedial costs generally will be deferred until completion of construction or at least until construction costs are well established. By going after known rather than prospective costs, the recovery process can be shortened and the prospects for successful and fuller recovery improved.

Under the remedial program, design and site completion projects will receive highest priority. We will also be initiating new remedial investigations and feasibility studies.

Dioxin related sites are to be treated in the same manner as other Superfund sites, with priority being given to the most serious public health or environmental threats. Increased emphasis will also be placed on ensuring appropriate cleanup of hazardous sites at or associated with Federal facilities.

The Agency is formulating its policy concerning applicability of other environmental statutes to clean-up actions under CERCLA. This policy will consider applicability of these laws when either taking a response action or approving responsible party cleanup through enforcement mechanisms. It will reconcile CERCLA's requirements for fund-balancing and cost-effectiveness with standards adopted by EPA or states under other regulatory authorities.

We estimate that the 22,000 sites we expect to eventually be identified in ERRIS will yield approximately 1,400 NPL sites, including the 546 currently proposed or listed. This is a lower-end estimate, however, as it excludes certain elements which could raise the number of NPL sites. An upper-end estimate is that approximately 2,200 sites will require remedial action.

Progress in the Superfund Program

Within the past several months, a number of important changes were made which were designed to bring the states increasingly into the Superfund program and to lay the foundation for increased momentum of the program. We eliminated some of the early cost-sharing that was required of states in order to initiate the remedial planning process. We also delegated certain responsibilities to our regional offices to permit decisions to be made closer to the site of the problem.

No longer must states cover 10 percent of the costs of remedial investigation and feasibility studies at priority sites. By covering 100 percent of these costs with Federal funds, states can become actively involved in remedial actions early in the process without straining their budgets and causing delay.

A more aggressive community relations program was keynoted with the issuance of a formal policy last May. We have distributed a handbook on community relations. This provides guidance on such essential elements as on-site discussions, public meetings, and other aspects of community affairs. An essential basis for all decisions on site remedies is the two-way communication among all principal actors--EPA, the state and the affected residents. Keeping citizens informed is particularly important.

Similarly, by holding off efforts to negotiate responsibility for site cleanup until after remedial investigation and feasibility studies are completed, we have simplified that process by framing

the terms for negotiating. Parties deemed to be responsible will know from the beginning what EPA expects of them. Thus, meaningful discussion can begin and be sustained, and cost-recovery actions can be undertaken in a clear-cut and efficient fashion.

We have delegated authority to our Regional Administrators to commit funds for emergency response actions in the belief that they are more sensitive to the needs for immediate action. Previously, these decisions were made in Washington, D.C.

In addition to simplifying some of the procedural steps associated with Superfund action, we have, in the past six months, backed up our promises with commitments and dollars. The level of remedial work has increased dramatically. During the first 27 months of the Superfund program, EPA spent $70.8 million on remedial projects at 111 sites. In the seven months from March 1983 to the end of the Fiscal Year, the Agency spent $54 million on work at 102 sites. During Fiscal Year 1984, we project spending $136.5 million on remedial activities at 147 sites.

Similarly, in the 27 months between December 1980 and February 1983, EPA conducted 114 removal actions at a cost of $25.5 million. From March 1983 through September 1983, we spent another $22.6 million for 93 removal actions. During Fiscal Year 1984, we anticipate conducting as many as 170 removals at a cost of $56 million.

A look at the Fiscal Year 1985 budget proposed by President Reagan shows significant growth in the Superfund program. The budget seeks $640 million for Superfund, up $230 million or 56 percent over the $410 million appropriated so far for the current Fiscal Year. We have also requested a supplemental appropriation of $50 million for additional activities during Fiscal Year 1984.

Much of the increase in Fiscal Year 1985 resources will be devoted to expansion of remedial construction projects at NPL sites. During Fiscal Year 1985, EPA plans to begin construction work at 46 sites, compared with 15 sites during the current Fiscal Year. By the end of Fiscal Year 1985, we expect to complete or have under way planning activities for cleanup at 396 NPL sites.

As you are aware, the remedial and removal activities I have discussed are funded largely through taxes imposed on the chemical and petrochemical industries. The authority to collect that tax, incorporated in CERCLA, expires at the end of Fiscal Year 1985. Superfund reauthorization has become a major issue before Congress, and will be debated at length throughout the year.

The President, in the State of Union Address, directed Bill Ruckelshaus to develop a plan to extend Superfund. We are currently involved in a thorough review of all statutory issues. By early next year, we plan to submit a package to Congress, in anticipation of passage of new statutory authority before the current program expires in September 1985.

PROGRAMS UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT

The objective of the RCRA program is to prevent future hazardous waste problems by implementing and enforcing a regulatory program which establishes cradle-to-grave management of the generation, movement, and disposition of hazardous wastes. This program establishes minimum technical standards for treatment, storage and disposal of hazardous wastes. The program is jointly managed by EPA and the States.

Status of the RCRA Program

The first set of RCRA hazardous waste regulations went into effect in November 1980, less than three and one-half years ago. Today, we have a complete file of generators, transporters, and facilities subject to these regulations, identified by name and location, and by waste and process. They have all registered with us and we have issued them I.D. numbers.

The cradle-to-grave control system for managing hazardous waste has been put in place. The manifest system is operating nationwide. People are using it when they ship their waste. States and regional offices are following up on exception reports. The manifest system appears to be working very well. Just this year we published a national, uniform manifest form that standardizes and reduces paper work and makes compliance inspections easier.

A very important set of interim standards has been applied to treatment, storage, and disposal facilities. There is now a nationwide requirement to monitor groundwater around land disposal facilities. This monitoring information will be invaluable in setting future program directions.

Liability insurance is now required at treatment, storage, and disposal facilities. Closure plans, post-closure plans, and financial assurance for closure and post-closure responsibilities are required to be guaranteed through bonds, trust funds, insurance policies, and other mechanisms.

Standards have been issued to be used to issue permits to many classes of facilities. These include facilities that store and treat hazardous wastes in tanks and containers, incinerators, facilities that dispose of wastes on the land in landfills, surface impoundments, land treatment facilities, and waste piles. All these rules are in effect.

We have delegated interim authority for various parts of the program to 45 States--this brings a tremendous amount of needed state resources and expertise to this area. We plan to delegate full and final authority to 45 states by January 1985. State programs are supported with financial assistance amounting to $47 million per year.

Revisions to the RCRA Regulations

In the coming years, EPA will work to develop revisions to the regulations to expand and strengthen the existing program. The emphasis will be on modifying the listings and characteristics of hazardous waste, amending the land disposal regulations, and regulating new classses of hazardous waste handlers.

Several regulations will be proposed to emcompass waste previously not covered: These rules will: (1) list waste from additional industrial processes, (2) amend our regulations to provide for consideration of other factors and constituents in reviewing delisting petitions, and (3) expand the toxicity characteristic to include additional toxic organic chemicals.

As a result of public comments and our own analyses, there are several sections of the land disposal regulations which will be amended. These include: (1) amending the liner regulations to require double liners and establish criteria for liner compatibility and leachate level monitoring, (2) revise the requirements which will place further restriction on the land filling of liquid waste, (3) amend the ground-water monitoring requirements to develop a more representative statistical test, (4) revise the regulation to address lateral expansion of existing units and establishing an effective date for the liner requirements for all units, and (5) developing guidance addressing hydrogeological location criteria.

Although the land disposal regulations provide standards to insure proper disposal of hazardous waste, we will also be developing requirements to restrict waste from land disposal. Dioxins and solvents will be the first wastes to be considered. Over time we expect to evaluate all hazardous wastes to determine whether their disposal on the land is inappropriate because of fate, transport and potential health and environmental effects. As part of this, we will identify treatment alternatives for banned wastes, including the available capacity of those alternatives.

EPA will also be reconsidering the current exemption of small quantity generators of hazardous waste. We will be completing a survey of such generators this year and will be evaluating state programs which regulate small quantity generators. Following this, we will be developing regulations to deal with these currently excluded sources.

The regulation of waste oil burned as a fuel is an issue of public concern. In the future, we will be developing regulations for the listing and management of waste oil as a hazardous waste. We will be proposing technical regulations addressing combustion of hazardous waste as a fuel and we will be promulgating administrative standards which will set specifications for used oil fuels and establish notification, manifest and recordkeeping procedures.

There are several new types of facilities and classes of waste which the Agency will be addressing for the first time. This will include regulation of undergound tanks containing hazardous waste. We will carry out an investigation of area source emissions from tanks, containers, and land disposal facilities, and will develop regulations if appropriate. We will complete regulatory anaylses of smelting and refining industry wastes and will prepare reports to Congress on utility and mining wastes.

In recognition of the expense involved in preparing and processing permit applications, EPA is developing a "class permit" which would simplify the permit process for specific groups or classes of facilities. This approach is appropriate for certain types of facilities less likely to threaten health or the environment. The first regulations for class permits for on-site storage by generators will be issued in 1985.

Compliance Evaluation And Enforcement

Compliance monitoring and enforcement will be carried out to discover violations and effectively bring the violators back into compliance. EPA and the states will aggressively pursue violators and provide disincentives for continued non-compliance. This will be done through penalty assessments to insure violators are complying with enforcement actions.

Inspections will focus on handlers whose activities pose the greatest threat to public health and the environment. EPA and the states will conduct compliance inspections at all facilities required to monitor groundwater, including incinerators. In addition, a percentage of other treatment, storage, and disposal facilities, and generators and transporters, will also be inspected. In addition, we will inspect all facilities permanently closed or closed during the previous year.

Compliance sampling inspections will be conducted at ground-water monitoring facilities where it is necessary to independently analyze the quality and degree of contamination of groundwater.

In addition to inspections, record reviews will be conducted to determine whether closure and post-closure plans, and cost estimates have been properly prepared, and whether financial assurance instruments have been properly executed.

EPA and the states will strive to reduce the level of non-compliance by taking frequent and visible enforcement actions. Compliance orders should be issued for each Class I violation discovered at both major or non-major handlers. Class I violations are those which pose the most serious threat to human health and the environment. Compliance orders for class I violations will frequently assess civil penalties. These disincentives, provided through penalty assessments, are significant, and EPA and the states should take advantage of them. Experience in other environmental programs has proven that the economics of not complying with regulations greatly exceed those of compliance, unless monetary incentives to invest the capital for compliance exist. Effective use of penalties provides these incentives.

In addition, criminal sanctions will be pursued in cases of deliberate non-compliance with RCRA that result in or threaten significant environmental contamination or that deliberately undermine the regulatory program.

We recognize that many states do not have the legal authority to administratively assess penalties. These states must pursue violators through civil actions in court. In addition, some states hesitate to implement their penalty authority even when they have it, preferring to use some more informal means such as warning letters or citations. This results in inconsistent nationwide enforcement of the hazardous waste program. Therefore, EPA will take action in authorized states when the state has not taken or cannot take timely or appropriate enforcement action.

The Permit Program

EPA and the states have an obligation to isssue operating permits to approxmately 8,000 existing treatment, storage, and disposal facilities. The permit program is very important because it is the vehicle through which we impose more stringent requirements on facilities. For example, it is the permit which supplies the requirements for liners and leachate collection systems for landfills. It is the permit which establishes destruction requirements for incinerators. Denial of a permit forces a facility to close if they cannot or choose not to comply with these standards.

Our priorities for the permit program will focus on land disposal facilities and incinerators. By the end of 1985, EPA and the states will call in all remaining land disposal and incinerator permit applications. This will constitute approximately 2,000 permit applications nationwide.

Permit processing and enforcement will be closely coordinated. Compliance inspections will be conducted shortly after a

permit application is requested. This will focus the facility's attention on appropriate ground-water monitoring problems at the earliest possible opportunity. Compliance schedules will be established for noted interim violations. When late and incomplete Part B applications are received, notices of deficiencies will be issued, and when complete applications are not forthcoming as a result of this, enforcement orders will be issued and penalties will be assessed.

Public participation in the permit process will also be emphasized. In addition to the required public notice and hearings, public meetings will be held to explain the process to the affected public.

Conclusion

In conclusion, in the coming years there will be an expansion and acceleration of the hazardous waste program both under CERCLA and RCRA. More sites requiring cleanup under the Superfund program will be identified. Remedial actions will move to the design and construction phase. More wastes will be identified as hazardous under the RCRA program and new facilities and processes will be subject to regulatory control. Enforcement actions under both statutes will increase, and permits will be issued to hazardous waste facilities to insure that they are designed and operated as necessary to protect human health and the environment.

EUROPEAN PERSPECTIVES

by
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You will understand when I say that if Walter Giles is indeed standing on the Great Wall of China, he stands there with my envy. There is a quite astonishing degree of unanimity in countries about the desire to manage industrial wastes and each country has its own quality of desire. The constraints are those of the perception of the social risk imposed from industrial wastes, tempered, I suppose, with the economic realities which each country faces. Now industrial wastes are intimately, inextricably tied into water supplies, and it should be noted at the outset that the conventional accepted opinion of the health risk is that industrial wastes have very little effect on international public health. Now this, first of all, doesn't appear to diminish this widespread concern for chemical waste disposal, but the figures are such that we understand that most public health problems associated with water, drinking water, are associated with microbiological quality. For example, there are something like 500 million cases of diarrheal diseases among very young children -- children in the range of 1 to 5 years old -- and about 3 to 4 percent of these are fatal. So we can look annually at a death toll of somewhere between 15 and 20 million children. This, it has been pointed out, is equivalent, if you remember it, to the disaster at O'Hare Airfield where we saw on television a DC-10 crash into the ground, taking 275 lives as it did so, and we were duly horrified at that. Well, if you translate this into engineering arithmetic, it turns out that about 275 children die every 10 minutes seven days a week, 365 days a year. That doesn't appeal to us much because these deaths that I'm talking about are so diffuse, so scattered through the world, it doesn't have that single horrifying impact of a DC-10 crashing into the ground. But those indeed are the sorts of figures we deal with and these indeed are the sorts of background we must keep firmly in mind. Again I repeat that as far as the medical evidence so far seems to indicate that

industrial wastes, chemical wastes, have very little effect on disease. Now I won't stop with deaths of young children -- there is indeed as sad a picture to be painted of disease causing disability, diseases that are not fatal necessarily, but certainly cause a tremendous loss of productivity throughout much of the world. But the perception is there. Each country has this perception that industrial wastes must be managed. And I think the reason for that is that everybody in the world, the Third World particularly, is accustomed to the idea that you can indeed make water clean for drinking purposes, microbiologically clean that is for drinking purposes, by boiling. There's not that same quality of assurance that you can boil water and get rid of chemical contaminants. Chemical contaminants are then seen as, in a sense, new and sort of mysterious and with the effects ill-defined. So there's this question of ill-ease with chemical industrial wastes. And we've heard in considerable detail this morning about Ontario and the U.S.A. I know that we've had many successes typically here in Ontario with the Tricil operation, for example, in Corunna, with Polysar's operation in Sarnia, both great successes in terms of industrial waste management. We're also quite well aware of the successes in the U.S.A., tempered, I suppose, by some failures too. But what about the rest of North America? Just for a moment, let's just think in terms of a neighbour well to the south of us in Mexico, and there the situation is rather bleak. Typically, there's one case I'm aware of, where industrial wastes are being discharged into the Lermer River which in turn debouches into Lake Chapala and Lake Chapala water is taken for the irrigation of the very rich agricultural area near Guadalajara. The question that arises in Mexico is, does this water, industrially contaminated, taken from Chapala affect soils, affect the crops, will it diminish the crops and the productivity of this rich agricultural area around Guadalajara as time goes on. And in truth, the Mexican Government isn't sure. Now this is

the sort of problem that we deal with, and have dealt with very successfully in Ontario on a number of occasions, in the Grand River basin, for example, in the Thames River basin. We have a good perception of what is likely to happen over time. Now that eludes so far the Mexican Government, but the perception, the uneasiness remains. Will the question be answered? I don't know -- I would certainly dearly like to make sure that we in Ontario and in Canada can help them to answer that question because we have the skill and expertise to do it. You first need a survey, you first need estimates of effect the course it does. But the answer and any remedies will be affected quite substantially by the industries in the area relating to the Mexican Government, whether indeed they think that the remedies can be afforded. And among the national industries in Mexico are those which will have a very marked effect on whether any abatement programs will take place. So here we see this constraint, this hedging, by industry -- a national industry, I want you to know -- I want to make that very clear -- a national industry -- as to whether or not the remedy can be afforded. You see a play of -- a need for industry -- a play of the need for agricultural production and they're vying with each other as to who will succeed in remedying the situation which appears to be arising in Mexico.

We turn our attention to Europe and we see there again many success stories -- Ebenhausen, the facility in Bavaria, Nyberg in Denmark -- both very successfully dealing with industrial wastes. We see the cement kilns near Oslo being able to burn PCBs using the technology and the information gathered, you will note, in Ontario here and winning a state prize for doing it. Very great success stories. But, on the other hand, in Europe we tend to forget at times that the program, the industrial waste management, has been marred too. Pitsea, if you remember Pitsea in Essex, you remember the coalite disposal in Derbyshire -- programs which tend to offset the ability in the U.K. to deal with PCBs or the

ability to provide the facility at the Stablex plant which are the success stories. So we have a balance of bad news and good news. We remember too the scandals in Holland which marred the industrial waste management in Holland. We remember Lekakirk and we remember the company who finished up in court for abuse of industrial waste management practices. We don't hear very much about Italy or Spain or Czechoslovakia or the Soviet Union. The chances are, I think, quite good that their success stories do not match those of Ontario or the States or Nyberg or Ebenhausen, or if they do, they've been remarkably quiet in informing us of their achievements. Maybe more typical is a state in Greece. Recently we've been asked to see if there was an interest in Ontario to remedy the disposal of petroleum industrial wastes in the area of Athens and its environs. A substantial problem apparently arises there where the petroleum wastes have not found a suitable home, not found a suitable confinement or destruction which we might look for here in Ontario. So all isn't well. There's some very bright spots indeed but by no means have the perceptions of the need for industrial waste management been met uniformly throughout Europe.

Again, we turn to the Middle East. It appears clear in the city of Cairo, which is now, I think, reaching a population of something like 10 million people, that waste, industrial waste and municipal liquid waste disposal is far, far from satisfactory. There have been several waste sewage treatment plants competent to deal with some industrial waste at least which have been built over the years, but which have been allowed to lapse into disuse or less than perfect use. And it's rather interesting to observe that the World Bank recently asked a consortium of a British and American consulting group to provide another answer for the wastes generated in Cairo, and even with the clear picture of, I think it's three, sewage treatment plants that have failed due to lack of maintenance -- not lack of engineering

but lack of maintenance in operation, operational ability, that is, that the response by these two consultants was: Build yet another sewage treatment plant, the bill for which came to something like $400 million. It's hardly the sort of remedy which the World Bank will swallow readily. After all, the World Bank has only about $13 billion a year to spread amongst the world -- it can't spend that kind of money in one city -- not with a record of failure such as has been demonstrated in Cairo. There's one classic story about Cairo, by the way, which I think is an interesting aside here. A recently built, very tall, very sizable, commercial office building has been completed -- only one floor is occupied because the rest of the building would further overload the already overloaded sewage collection system -- an interesting sort of aside in the commercial aspects of what can happen if you don't have the capacity to manage wastes, including, as I say, some of the industrial or commercial wastes.

We expect that in Saudi Arabia the new petrochemical towns of Jabayal and Yanbu will be served with industrial waste disposal and again I haven't really heard that -- I'm not perfectly sure that has been well looked after. One thing is certain, they will have the money to pay the bill. One thing is equally certain, Egypt won't. Egypt will not have enough money to pay the sorts of bills that are to be expected in the cleansing of Cairo. It would be silly in the extreme to expect any substantial waste management to occur in either Iraq or Iran -- they're far too busy with the war -- and indeed a great deal of money that could have been expended on social programs will not be expended because of these narrow interests which are being served by countries such as Iran and Iraq.

We turn now to some of the Asian countries where we should be interested because they're going to give us a good run for our money industrially. And I think you and I should have some perception of what sorts of levels of

interest in things like industrial wastes propel the nations in Asia. China itself, the People's Republic of China, that is, are indeed showing a very deep concern for industrial wastes -- airborne wastes as well as waterborne wastes as well as solid wastes -- and they've set aside for the next 10 years $10 billion (U.S.) or their equivalent for pollution control. Now before we get too excited about that, just let's bear in mind that $10 billion is about the amount of money that it would cost to replace the present sewage and water services in Toronto alone. So we're talking a city of 2 million (Toronto), the worth of the pipes and the treatment plants, water supply and sewage, is about $10 billion. So we're talking here $10 billion which has got to dent, make some sort of impression on the environmental lives of a billion people in China, including cities such as Shanghai by which Toronto pales almost to near insignificance in population. Bear in mind too that in China we're talking about annual incomes of something like $400 per year per head. In Ontario we're talking about annual incomes per head again of about $15,000. We're talking along a very wide spread in the ability to discharge debts and discharge industrial waste too, of course. But China does have steel industries and chemical industries, textiles with dyes, pesticides, and all the other ingredients that concern us. One of the problems that China has right now which in a sense touches upon this question of industrial wastes is the pesticides residues in some of the foodstuffs which it's competent and capable of exporting. They can't export to nations such as ours because the pesticides residues are greater than those which we are prepared to accept, which indicates a lack of control, a lack of management of pesticides. And, after all, when you think about it, pesticides that remain in unwanted quantities, I suppose in a sense, is a sign of pesticide waste mismanagement. And this question of management of wastes, in a sense, will supervene the question of engineering of wastes and this will take me quickly into the point that Professor Jones has made about the training capability. And as much as we would tend

to think in terms of engineering as providing an answer, it doesn't provide anything like a complete answer. The engineering has got to be coupled with training and education of what to do competently, economically, with wastes.

But the end result is a country like China needs industrialization. It needs a base upon which it can command its future. Now with that ability, of course, comes the payoff which is the waste part which has to be looked after.

And the same sort of story goes for South Korea and where very clearly industrialization has improved the whole social fabric of the country. Now of the 38 million people in South Korea, probably less than half, rather less than half, have got flush toilets or latrines. The remainder are still into nightsoil collection or no nightsoil collection. That means that the human waste problem remains untended, but considerably better than it was in years gone by. The gross national product in South Korea has risen from about $400 per capita per year in 1960 to $1,200, tripling the annual per capita income. And this has shown up very clearly in the results -- a growth rate of about 80 percent. Public health has improved enormously and typhoid and diphtheria are down to about a twentieth of what they were in 1960. Cholera outbreaks -- and we still talk cholera -- have diminished except for the odd punctuation of small outbreaks in 1970 and 1980, but not the horrible ones where thousands of people are affected, ones in which the victims are counted rather in the hundreds. And that's success, and that success has come with industrialization. But there's also a price. And the price has been a very heavy increase in industrial pollution. For example, in the Pusan area in the south part of South Korea, red tides are reported there. There's an increasing background of coliform bacteria stemming from untreated sewage, and you can

equate that in some way with untreated industrial wastes too. The most probable number of coliform bacteria per 100 mls in the coastal area, a rather wide coastal area, is running nearly 600 coliform bacteria. About 25 percent of the B.O.D. discharged into the Han River at Seoul, the capital of South Korea, about 25 percent of it is from industry. So here we see another sign that industrial capacity increase has also brought about with it an increase of pollution of the local river. But it is now quite clear that the South Korean government is interested in water management. For example, it's sending a team, one other team, for they've been here once, from Seoul to Toronto to have a look at our water treatment plants. Promising from a number of points of view -- from the point of view of we, as an exporting nation with environmental capability and secondly, promising from the point of view of the good citizens of Seoul who are likely to get a substantial improvement in water delivery and the quality of water delivery.

Indonesia is a kind of special place in my mind. In Jakarta, the capital city, we've got about 6.7 million people. Per capita income there $700 per year. Again, contrast that with the $15,000 per head per year we in Ontario. With that 6.7 million people, it's sometimes hard for us to think that there's no sewage service in the city whatsoever. None. And the water supply system is dilapidated. Much of the system is leaky. The primary pipe, for example, which is supposed to be inviolate for use and merely to supply the secondary supply system and the tertiary behind it, it is breached. Many people who command responsible posts in government do get their water from that primary pipe, so the people at the back end of the system aren't getting much in the way of water. Now the water that is supplied would not, by any manner or means, pass any test in Ontario for its quality. It's heavily contaminated with micro-organisms but when I spoke to some of the people in Jakarta about water quality, it was quite noticeable how quickly the conversation

went to industrial wastes. The water supply, the water quality was not of commanding interest to most people because, again, the custom, the tradition of water was that it would be contaminated and there was an expectation that this had been so for many years and microbiologically you could cure the problem merely by boiling the water. So the intellectual problem was one of industrial waste. Now there are some good reasons for this. Many of the industrial plants are owned by the government and it gives the government some embarrassment to think that they are a part of the problem. And some of the discharges -- there's a substantial discharge of mercury, for example, organics from dyestuffs, plating wastes, and the like. Many of the industries, many of the industries are quite small though, and will elude ready control -- they will not be easily abated -- but the big industries are mostly government-owned, and there's a rather interesting system of ownership. Many of the industries are owned and operated by ex-Army people -- it's a form of pension -- so that when you leave the Army, then you become a manager of, say, a glass plant or a textile mill or the like -- that's your pension. Now you can imagine that when the moment of truth comes and abatement is required, that ex-Army officer, that ex-civil servant will be looking very carefully to see what this does to his pension, whether it will abridge or diminish the amount of money he gets per year. So I don't really expect there to be a wild enthusiasm for abatement programs that may be expensive, nor indeed can they be expensive because the money base just will not be there. The key element in the economy in Indonesia with its 150 million people is the production of rice. And there there's a great industrial, agriculturally industrial success story. Over the last 20 years, the productivity of rice in Indonesia has nearly tripled and in part at least, that tripling can be accounted for by the use of pesticides. Now that doesn't mean to say that pesticides have been carefully used, but they've been used effectively in terms of production.

I'm reasonably convinced in Indonesia it's been done thoughtfully. And one of the key things I've looked for is what sort of losses of crops occur after harvesting. Throughout much of the world, between a quarter and a third of the crop is lost due to pests after harvesting due to either beetles or rodents, one form or the other, the quality and quantity of the remaining crop is abridged. The same story goes in Thailand and in Bangkok which is a wonderful, wonderful city, a great place, with about 5-1/2 million people and a per capita income of about $1,000 a year, rather better than it is in Indonesia -- again, no sewers, none. And the water supply system is new but in very poor repair. They claim in Bangkok that they've got the biggest water treatment plant in the world. The misfortune is that the intake works are collapsing, probably because the ground's collapsing, it's sinking at the rate of 4 or 5 inches per year -- it doesn't have far to go, it's only about 3 feet above sea level. But the ground is sinking quite rapidly. Part of the reason for that is the fact that they draw from the water within the greater Bangkok area about 300 million gallons a day. I say that figure because I want to give you an appreciation of just how much we're talking about. Toronto here, I think uses something of the order of 240 million gallons a day. But the subsidence of Bangkok, a large part of it, is attributable to the pumping of water. Out of that 300 million gallons a day, about 180 million gallons go to industry, and what industry discharges is not coming out clean obviously. About 40 percent of the B.O.D. coming from the city of 5-1/2 million people, 40 percent of it comes from mine industries, and I don't talk here about the chemical quality but merely the biological quality -- not a perfect but not a bad indicator of the sorts of levels of discharges that do occur in large cities. They're not by any manner or means cities without industries, as you can tell. Again, I say the cities that do discharge their wastes

without treatment. Residences discharge their wastes into the ground. When I say many people have flush toilets, yes, they do, but the flush toilet goes into a tank in the ground - with a retention time of one or two days, not much more - with a pipe at the top of the tank out of which the discharge effluent goes into the soil. Now Bangkok, because of its subsidence, suffers quite disastrous floods every two or three years and it's a common sight and rather a sad sight to see the pictures of Bangkok's floods again -- people wading through the water. This water, of course, is contaminated, very heavily by now, with the human effluent that is present in the city. And the canals which were used traditionally to remove excess water are heavily plugged up with wastes, human wastes among other things, which thwart the ready removal of the flood waters. Nevertheless, Bangkok is interested in industrial waste. It has selected sites which will be used for industrial waste management. I'm very happy to say that there was at least one Canadian company in there pitching to make its presence felt in the matter of waste management. Just going back to that B.O.D. figure, of 150,000 kilograms of B.O.D. a day going into the local river, the Chapraya River, and about 40 percent of that is from mine industries.

But in the back of Thailand, in the hinterland, Thailand is one of the most impportant rice-growing countries in Southeast Asia. It's always been the country which had excess rice to export. A very interesting sidelight here. Thailand is not the most productive now, despite the fact that it has traditionally taken the role as being the exporter of rice to countries which are rice-poor, it is beginning to lose its position, and there 25 percent of the rice crop is lost after harvesting due to poor post-harvest management. An interesting sidelight before I depart from the rice picture which is obviously of very, very great importance -- the priority item in Southeast Asia. Although the rice production has doubled in the last 20 years, the

amount of rice per head of population has only increased between 5 and 10 percent -- that's the amount of rice available per head -- so this question of starvation is never that far away. Two years ago when Indonesia had a drought problem, several hundred people died of starvation. That's not typical, mind you, but here we see on the one hand, it's a question of pesticides use, pesticides misuse, promoting some difficulty with waste because obviously anything that hasn't been used up -- the pesticide hasn't been used effectively in controlling the target pest is a waste, whether you dispose it in a landfill site or whether you dispose of it in an agricultural area, it still has to be in your mind as prospectively affecting the environment. And I believe again that we run into the question here of waste training, the ability to look after pesticides because it's probably the most broadcast, the least confined of our wastes, and I believe here that we in North America have something to impart to our friends and hopefully our customers in Southeast Asia.

A very different matter arises in Singapore. Here's a small country, 2-1/2 million people, stuck in the end of the Malaysian peninsula. Very rich, very powerful, very aggressive, giving Hong Kong a run for its money, believe me. A million barrels of crude refined a day -- that's it's refinery capacity. Second busiest seaport in the world. It has one misfortune -- it doesn't really have enough water within the country. It imports water from its neighbour in Malaysia. So what it's doing, in the centre of the island, it has set aside a catchment area for the use of the production of local water. And, of course, it's extremely anxious that nothing impairs that catchment area. It is frightened lest some trucker, inadvertently or otherwise, dumps loads of industrial wastes into the catchment area to impair its national resource. So it has demonstrated a very keen interest in wanting information on how to manage its wastes, has the money to pay for it, has the will to do it, has the

political capacity to do it well, and in the last week we had some friends here from Singapore, from the Singapore Ministry of the Environment, looking at how we do it here, looking at the waybill system, looking at Tricil, looking at Polysar's operation, talking to many of our consultants, some of which are in the audience, about the sort of approach which can manage and account for industrial wastes with a sort of mastery which is required in good industrial waste management. And I'm sincerely hoping that they will follow some of the practices which we've introduced here in Ontario because they are good.

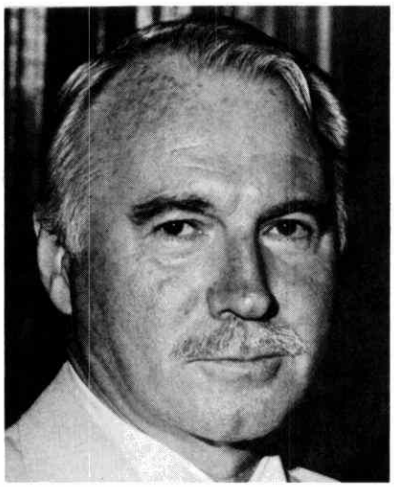
And lastly, a word about Malaysia, a pretty little country, advancing rapidly, rich in tin and rubber and palm oil. Hard to define a substantial industrial waste problem and yet in the newspapers there were these concerns being expressed for ill-managed wastes from palm oil refineries, particularly concern for misuse of pesticides again -- pesticides which were far too freely used by people who didn't have the capacity or the training to use them well. Many of the chlorinated pesticides such as DDT still widely used and often abused. Water being contaminated with pesticides -- fish in the water being contaminated with pesticides and, therefore, some embarrassment, some abridgment of the ability to use the protein source which the fish provided in the diet of the Malaysian rural dweller. Then we see this need for industrial waste management, waste being defined in a broad term, such as in pesticides and the agricultural industrial area, and more precisely in terms of industrial wastes in industries, the traditional industries like the palm oil industry.

So I've tried to draw some sort of a picture of industrial wastes, where they seem to be going, perceptions which seem to surround their generation through much of the world, and at that stage I think I'd better leave it. I had better leave it, it's 12 o'clock.

Thank you very much, Mr. Chairman.

SESSION II – AIRBORNE POLLUTANTS

Chairman: D.P. Caplice, Assistant Deputy Minister, Regional Operations Division, Ontario Ministry of the Environment Toronto, Ontario



E. Wiklund, General Manager, Chemical Technology, Boliden Contech AB Helsingborg, Sweden

B.A. Steiner, Senior Project Engineer, Armco Inc., Middletown, Ohio

M.F. Tunnicliffe, Deputy Chief Alkali and Clean Air Inspector, Health & Safety Executive, London, England

Dr. S.N. Linzon, Supervisor, Phyto-toxicology Section, Air Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario

ENVIRONMENTAL CONTROL OF MERCURY, ARSENIC AND SO_2 IN THE BOLIDEN SMELTER, SWEDEN

by
Elof Wiklund, General Manager, Chemical Technology, Boliden Contech AB,
Helsingborg, Sweden

Boliden is one of the leading European industrial groups in the fields of mining and refining of sulphide ores and the production of non-ferrous metals and inorganic chemicals. Group operations also include international trade in industrial raw materials, contract management and consulting activities as well as marketing of applied Boliden Technique and know-how.

Net sales of the Boliden Group in 1983 totalled SEK 5,500 million (USD 700 m), with around 8,500 employees. The Parent Company of the Group, Boliden AB, has its head office in Stockholm.

MINES

The origin of the Boliden Group was the discovery, in December 1924, of an arsenic ore with a high gold content close to what today has grown to be the municipality of Boliden in the northern Sweden.

Today the Group's mining operations are handled by the subsidiary Boliden Mineral and comprise exploration, mining and production of concentrates containing copper, lead, zinc, silver, gold and pyrites.

At present sixteen mines and seven concentrators are in operation. Approximately 16 million tons of ore are mined annually, with a content of 60,000 tons of copper, 70,000 tons of lead, 130,000 tons of zinc, 170 tons of of silver, 3 tons of gold and slightly more than 200,000 tons of sulphur.

The incomparably largest source of ore is the Aitik Mine, an open pit operation outside Gällivare in the far north of Sweden. At Aitik, the largest copper mine in Europe, around 40,000 tons of copper, 25 tons of silver and about one ton of gold are extracted from annual production of more than 11 million tons of the extremely low grade ore (0.4 percent copper).

Boliden's largest underground mine is Laisvall, the largest lead mine in Europe. About 1.5 million tons of ore, containing nearly 55,000 tons of lead, are mined here each year.

METALS

Most of the copper and lead concentrates from the Group's mines are treated by the subsidiary Boliden Metall, whose smelter is located outside Skellefteå, in the north of Sweden.

The smelter is the only integrated smelter and refinery in Sweden for complex ore concentrates and secondary smelter materials. The main products are copper (100,000 tons per year), lead (55,000 tons per year), silver (300 tons per year) and gold (5 tons per year). A number of by-products including sulphuric acid, liquid sulphur dioxide, arsenic, nickel, sulphate and selenium, are also produced.

Lead concentrates from the Boliden mines and silver-bearing bullion from Boliden Metall's smelter are used by the associated company Preussag-Boliden-Blei at Nordenham, West Germany, to produce 120,000 tons of refined lead and lead alloys annually.

Zinc concentrates - of which Boliden is one of Europe's largest producers - and zinc-rich clinker, extracted at Boliden Metall's smelter from copper and lead slag, are delivered to the associated company Norzink at Odda, Norway, where 90,000 tons of refined zinc metal are produced. Figure 1.

CHEMICALS

The iron pyrites from the Boliden mines are used to produce 600,000 tons per year of sulphuric acid at the Group's chemical works, Boliden Kemi, at Helsingborg in the south of Sweden. The acid is used there as the basis for production of a wide variety of inorganic chemicals such as phosphoric and hydrochloric acids, sulphates, phosphates and chlorides.

Boliden Kemi is the leading supplier of inorganic chemical commodities in Scandinavia. The products are used in the pulp and paper industries, water treatment, farming and in many other sectors of industry.

The principal products for the pulp and paper production are liquid sulphur dioxide, sulphuric acid, sodium sulphate, soda, aluminium sulphate, aluminium hydroxide and kaolin.

Water purification is another Boliden Kemi specialty. The company supplies almost all of the chemicals used to purify potable water in Sweden. Boliden Kemi also has a dominant portion of the market for the purification of municipal and industrial waste water.

An important element in Boliden Kemi's marketing of chemicals is the ability to offer customers complete systems comprising equipment, process technology, environment protection technology and service, as well as chemicals. Figure 2.

INTERNATIONAL TRADING

Increased internationalization is an important element in the Boliden Group's strategy for the 1980s. To coordinate and further develop the Group's international operations, the Boliden International group of companies have been formed.

Boliden International's operations are based on trading in, and transport of, ore concentrates, chemical products and other industrial raw materials, as well as on the sale of technology and international consulting and contracting operations.

CONSULTING AND CONTRACTING

Boliden's extensive specialized technical know-how - in combination with the subsidiary WP-System's long and diversified experience in construction work, site supervison and project administration - is valuable internationally.

The Group's foreign operations in the construction field and the sale of technology are managed by Boliden Contech, a Stockholm based subsidiary to WP-System and a member of the Boliden International Group of companies.

Boliden Contech's own team of specialists is backed by the combined resources of the entire Boliden Group in the fields of exploration, mining and mineral processes, as well as metallurgy and chemical process engineering.

Boliden Contech undertakes consulting assignments in those fields as well as in the environmental protection and energy areas, where the Boliden companies have thorough experiences with reference a.o. to the rigorous Swedish Environmental Protection Act 1969. Boliden Contech's operations also include the sales of licences and the management of turnkey construction projects. Access to the financial resources of the Boliden Group and the close cooperation with the Group's international trading organization, increases Boliden Contech's possibilities to develop attractive business combinations.

Air Pollution Control

CONTROL OF SO_2

The present values for the emission of SO_2 in Sweden are shown in Table 1.

Table 1

Maximum average value of SO_2 in air.

Period	Microgram/m^3	% of total time
October-March	100	
24 hours	300	2
1 hour	750	1

There is an aim to reduce said values to 60, 200 and 750 micrograms/m3 respectively. It has not been stated however, when these values will be introduced.

From the values given it is evident that you are allowed to reach the 300 micrograms/m^3 value maximum 7 days a year. The highest value 750 micrograms/m^3 is limited to maximum 7 hours per month.

The emission values are basis for the emission of SO_2 that each individual company is allowed to emit to the atmosphere. Existing companies and those that are planning to install a plant from which an emission of SO_2 can be expected have to negotiate with the National Swedish Environment Protection Board to establish the figures for the comming emission values.

As far as Boliden is concerned a vast program has been accomplished to reduce the emission of SO_2. Especially in the metetallurgical plant at Skelleftehamn a number of installations have been made.

METALLURGICAL PLANT

The gas stream from the different plants has been collected to form three main flows of gas. One flow is rich enough in SO_2 to feed two sulphuric acid plants with gas containing more than 3.5 % by volume of SO_2.

The other flow containing less than 3 % SO_2 is used for fabrication of liquid SO_2, which is produced in two plants. A third stream containing SO_2 too low to be economically possible to treat is collected from a number of ventilation places and is transferred to the main stack.

The present values of SO_2 emitted to the atmosphere in comparison to the values accepted by the National Swedish Environment Protection Board are shown in Table 2.

Table 2

Source	Amounts of emitted SO_2 tons/year Actual value	Accepted value
Sulphuric acid plant 1	500	1,200
Sulphuric acid plant 2	1,500	3,600
Liquid SO_2 plants	500	1,500
Other sources	9,500	14,700
Total	12,000	21,000

This year it has been decided to revamp sulphuric acid plant 2 to the double conversion, double absorption process. When this reconstruction work has been completed the expected and by the authorities requested value of emitted SO_2 from said plant will drop to 500 tons per year.

CHEMICAL WORKS, HELSINGBORG

The main sources of SO_2 at the chemical works are the plants for roasting of pyrite. The SO_2 purposely produced feed three separate sulphuric acid plants and a plant for production of liquid SO_2.

From most of the other units for production of heavy chemicals SO_2 is also emitted, mainly from combustion of oil.

The amounts of emitted SO_2 become evident from Table 3.

Table 3

Source	Amounts of emitted SO_2, tons/year Actual value	Accepted value
Sulphuric acid plant 1	816	1,140
Sulphuric acid plant 2	1,960	3,360
Sulphuric acid plant 3	916	1,140
Other sources	684	1,074
Total	4,276	6,714

It has been decided to reconstruct plant no 2 by 1985 to the double absorption system, already in use in the two other plants. After the revamping of said plant the emission of SO_2 will be reduced by 1,470 tons per year.

The total amount of emitted SO_2 will be further reduced as it has been decided to change the fuel from oil to natural gas in the near future.

MERCURY CONTROL

In the raw materials used for production of metals and sulphuric acid mercury is present. A portion of this mercury is evaporated as metallic vapour by the treatment of the raw materials and is found in the gas from the different roasting and metallurgical stages.

To prevent the mercury to collect in the acid and other products and to reduce the amounts emitted to the atmosphere several measures have been taken.

The present emission of mercury is presented in Table 4.

Table 4

Mercury emitted to the atmosphere in kg/year

Source	Actual value	Accepted value
Metallurgical works.		
Sulphuric acid plants	26	120
Liquid SO_2 plants	73	150
Other sources	611	530
Subtotal	710	800
Chemical works:		
Sulphuric acid plants	12	36
Other sources	traces	traces
Subtotal	12	36

To arrive at the figures presented mercury removal equipment has been installed. At the metallurgical works the gas streams to the largest sulphuric acid plant and both the liquid SO_2 plants are purified from mercury.

At the chemical works one of the sulphuric acid plants is equipped with an installation that removes mercury from the acid produced in said plant and a portion of the acid produced in the two other plants.

All the three plants are equipped with a mercury removal step in conjunction with the first gas washing step using Se as an active agent present in the raw material used.

In this way the acid produced at present contains below one ppM of mercury.

CONTROL OF ARSENIC

The concentrates used in the metallurgical works and the pyrites used in the chemical works contain arsenic. As the products produced from the gases resulting from the thermal treatment of the raw materials and the fact that the contact process for production of sulphuric acid requires an efficient removal of the arsenic from said gases, there is no appreciable amount of arsenic emitted to the atmosphere from the acid and the liquid SO_2 plants.

At the metallurgical works the arsenic is recovered in dry form and subsequently refined to white arsenic. At the chemical works the arsenic is recovered in wet form and the collected crude arsenic is sent to an arsenic refinery plant.

There is however an emission of arsenic to the atmosphere from other sources, i.e. converters, slag fuming, tank house and ventilation of altogether 33.5 tons per year This figure has to be brought down in the future to below 26 tons per year according to the authorities.

Air Pollution Control Installations

CONTROL OF SO_2

Sulphuric acid plants

As already mentioned, decisions have been taken to install the double conversion/double absorption process in two of the existing sulphuric acid plants at the chemical and metallurgical plants. This process is well-known and increases the yield of SO_2 from say 97% to 99.5 %. After completion of said installations only one of the existing five sulphuric acid plants, the smallest, will work according to the single contact process. The exit gas from a DA/DC plant contains less than 400 ppM of SO_2.

Liquid SO_2-plants

Two plants have been installed. The SO_2-content in the gas is absorbed in cold water in an absorption tower and is subsequently stripped off from the water with steam or heated water. After drying of the 100 % SO_2 gas it is finally condensed by cooling.

The reason for selecting this process is the natural supply of cold sea water and surplus of low level energy, i.e. steam from waste heat boilers and warm water from cooling of sulphuric acid. At a water temperature of 10°C the gas emitted to the atmosphere contains only 500 ppM of SO_2. Figure 3.

CONTROL OF MERCURY

Boliden has installed five different processes for removal of mercury in its own plants. Four of these processes remove mercury from gas, whereas the fifth removes the mercury from the acid produced. Boliden has also developed a sixth process for removal of mercury from gas. This process based on the use of mercuric chloride as the active substance is installed by Norzink at their Odda plant and by several other producers of zink. Figure 4.

BOLIDEN INSTALLATIONS

METALLURGICAL PLANT

Selenium filter

The gases used for production of liquid SO_2 are first cleaned in wet electrostatic precipitators and are then compressed to 1.2 bar by a blower for transfer to treatment in two parallel selenium filters. This equipment contains a vertical, cylindrical filter element consisting of a porous inert material coated with active selenium. The gas containing 15-30 micrograms/SCF of mercury is forced to pass through the filter element radially and mercury reacts with selenium to form mercury selenide, HgSe. The gas leaving the filter has a mercury content of 1.5 -3 micrograms/SCF, i.e. the collection efficiency is about 90 %. Figure 5.

Carbon filter

In the sulphuric plant the gas is forced to pass three in parallel working filters consisting of active carbon. The gas is first dried with sulphuric acid under conditions preventing the present mercury to be absorbed by the acid. The mercury is absorbed on the surface of the carbon, which can absorb 10-12 % of its own weight.

For efficient absorption the temperature must be lower than 50°C. Normally the efficiency is 90 %. Figure 6.

CHEMICAL WORKS

Selenium scrubber

The gas from the roasters is washed with diluted sulphuric acid and selenium liberated from the sulphide concentrate by the roasting process reacts with the elementary mercury in the gas in contact with acid.

To be efficient this process requires a ratio between the selenium and mercury in the raw material of 2 to 1 and a good contact between the acid and the gas to be washed. About 90 % efficiency is achieved. Figure 7.

Two stage gas drying

The roaster gas is first cleaned in wet electrostatic precipitators to remove the mercury in particulate form and is then contacted with 80 % sulphuric acid for removal of main amount of water present in the gas. At the temperature below 40°C elementary mercury is not absorbed by the acid.

In the following drying tower the predried gas is contacted with concentrated sulphuric acid, which is loaded with mercury separated from the gas. The acid is also contacted with a stream of SO_3 from the converter and mercury is then oxidized to mercuric sulphate which readily reacts with the mercury vapour in the gas.

The amount of acid formed in the secondary dryer amounts to only 1-2 % of the production of acid in the sulphuric acid plant.

The efficiency of this process is very high. Only 0.1 ppM or less mercury is found in the acid produced. Figure 8.

Acid purification - thiosulphate process

The acid is diluted to about 80 % sulphuric acid. In an agitated tank the diluted acid is treated with a solution of sodium thiosulphate and mercury sulphide is precipitated and subsequently filtered off.

This process is working in conjunction with the contact process and the purified diluted acid is used as make up acid for the absorption stage of the contact process. In this way the acid free from mercury is produced in concentrated form. Figure 9 shows the process in conjunction with the sulphuric acid process based on pyrite.

CONTROL OF ARSENIC

Metallurgical plant

Dry arsenic separation process

The roaster gas is quenched with a solution produced further downstream of the process to cool the gas from a temperature of ca 350°C to 110°C. The quencing of the gas is performed in such way that wet spots are avoided.

At the lower temperature the arsenic contained in the gas precipitates and is subsequently separated in a filter and is produced in form of a dry powder, which can be pneumatically transported to a bagging plant.

The gas leaving the filter still contains about 10 mg/Nm^3 arsenic which is subsequently separated in a wet electrostatic separator. Figure 10.

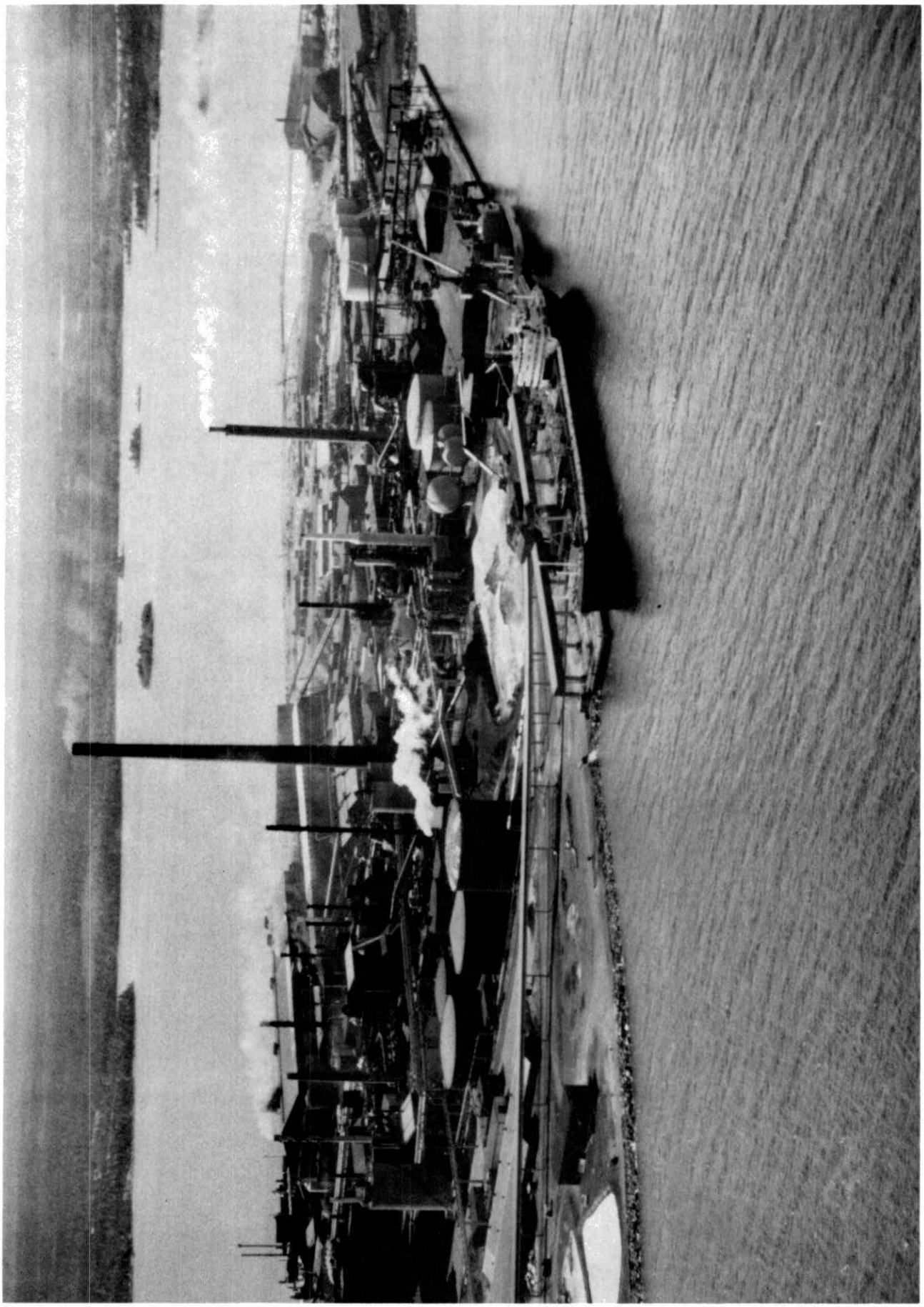
Chemical works

Wet arsenic separation process

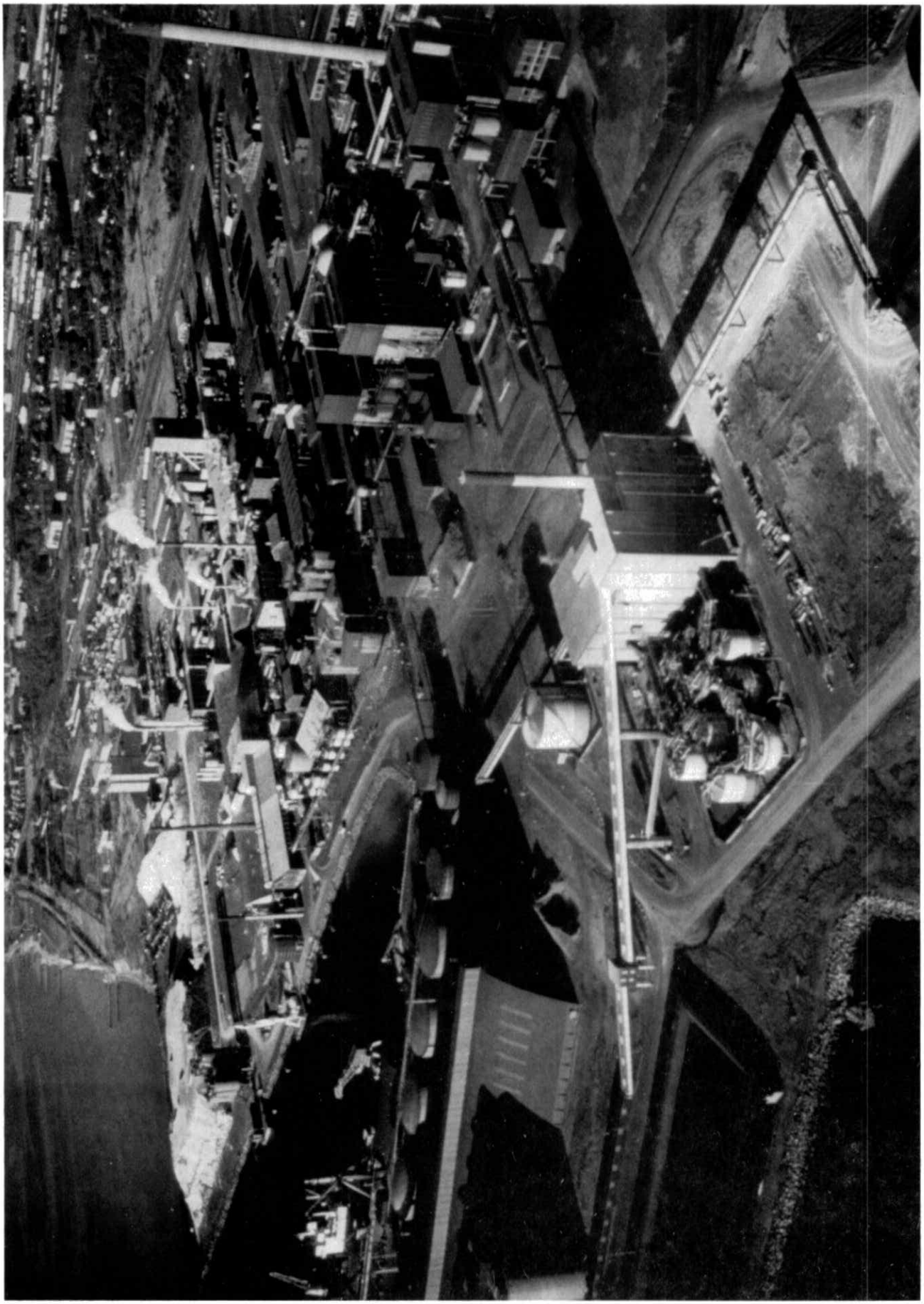
The roaster gas is washed with 60 % sulphuric acid. The arsenic contained in the gas condensates and is crystallizing on the surface of already existing arsenic crystals in the acid. The amount of arsenic crystals in the acid is an important factor to control the process which is operated under adiabatic conditions. The arsenic crystals are filtered off from the acid, which is recycled to the process.

This process is applicable for limited amounts of arsenic in the gas to be treated and in cases where large amounts of SO_3 are present in the gas.

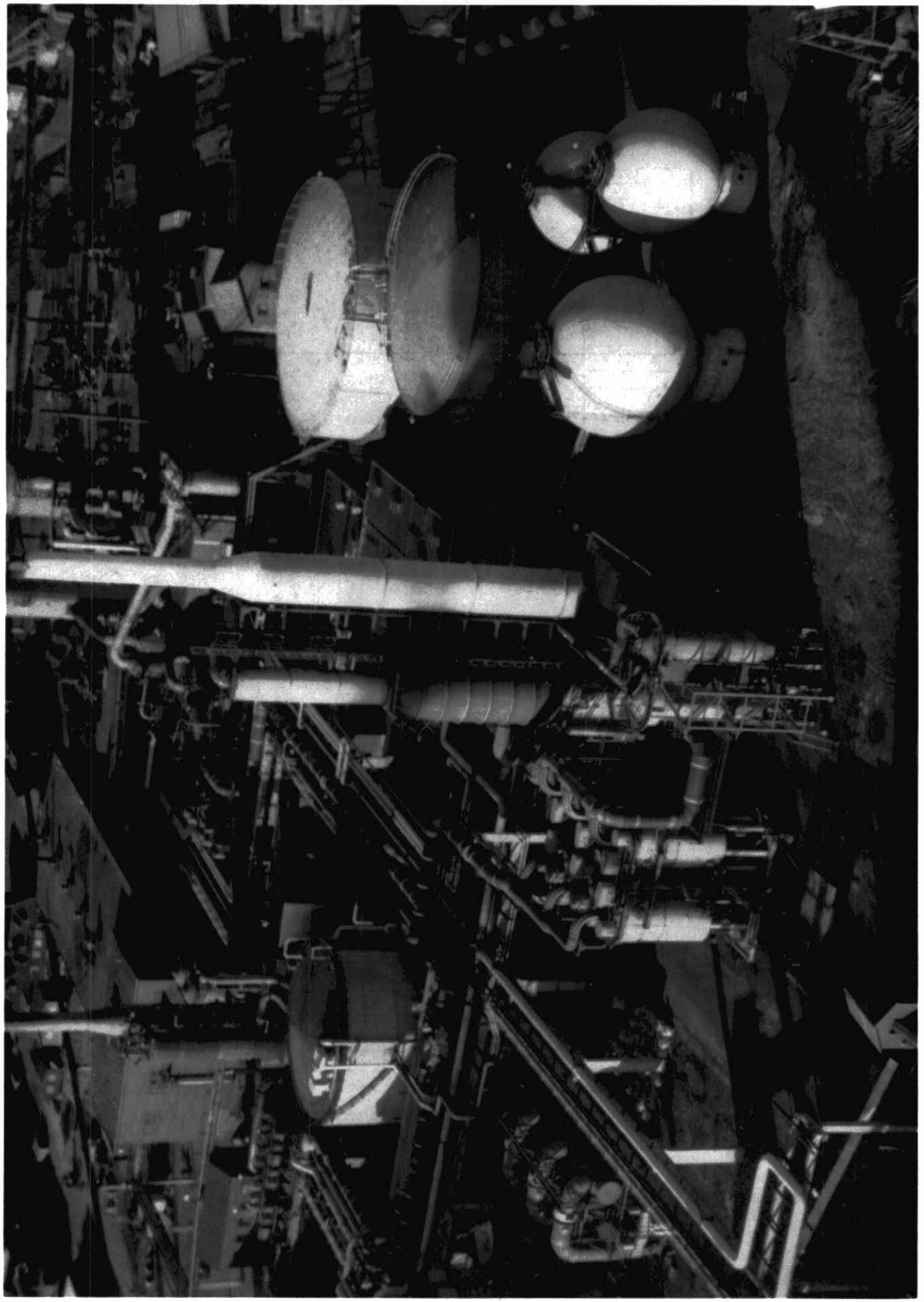
A semi-refining process is used to bring up the purity of the crude arsenic produced to about 90 % As_2O_3 before it is refined to white arsenic. Figure 11 shows the principal procedure.



PICTURE 1



PICTURE 2



PICTURE 3

FLOW DIAGRAM OF BOLIDEN - NORZINK MERCURY REMOVAL PROCESS

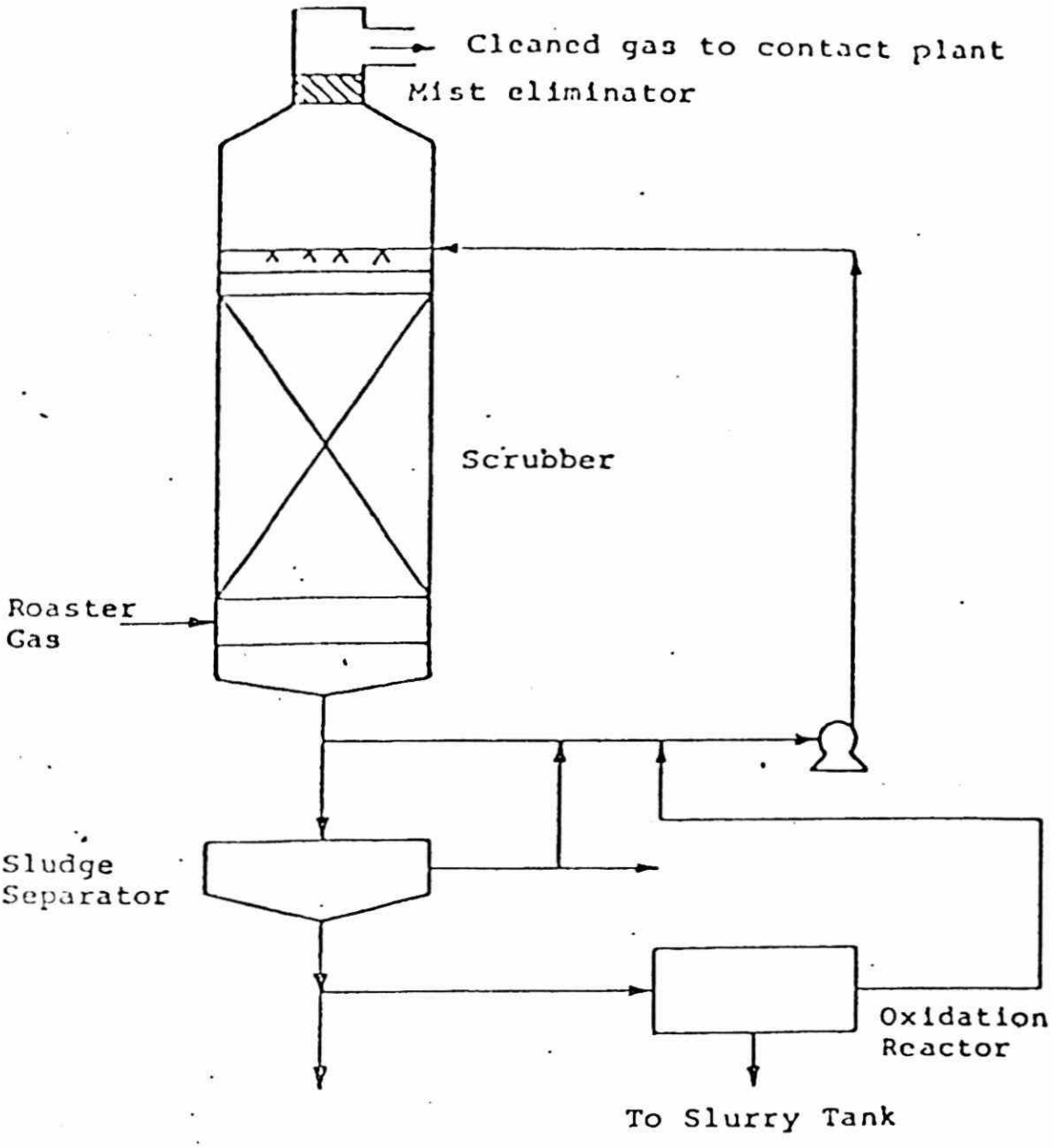
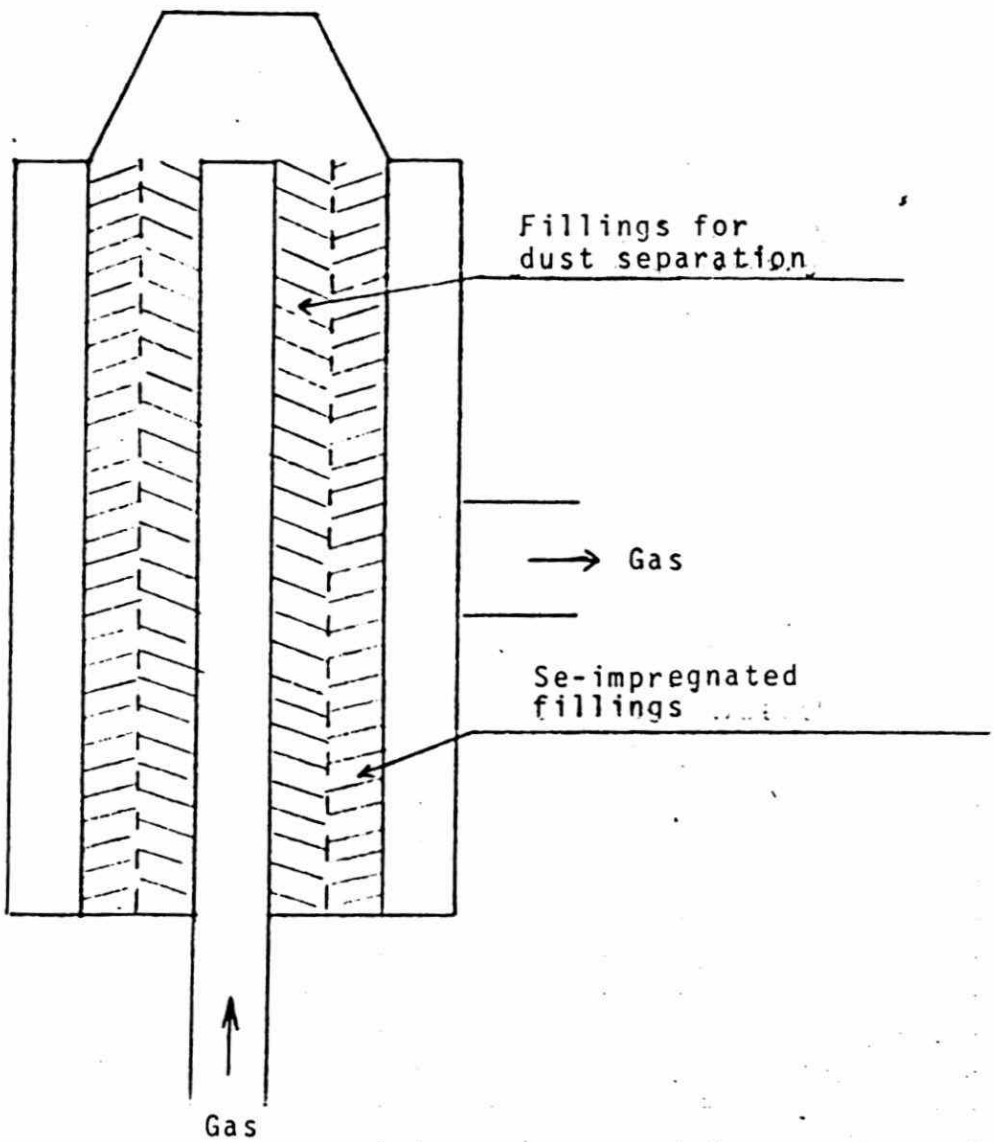


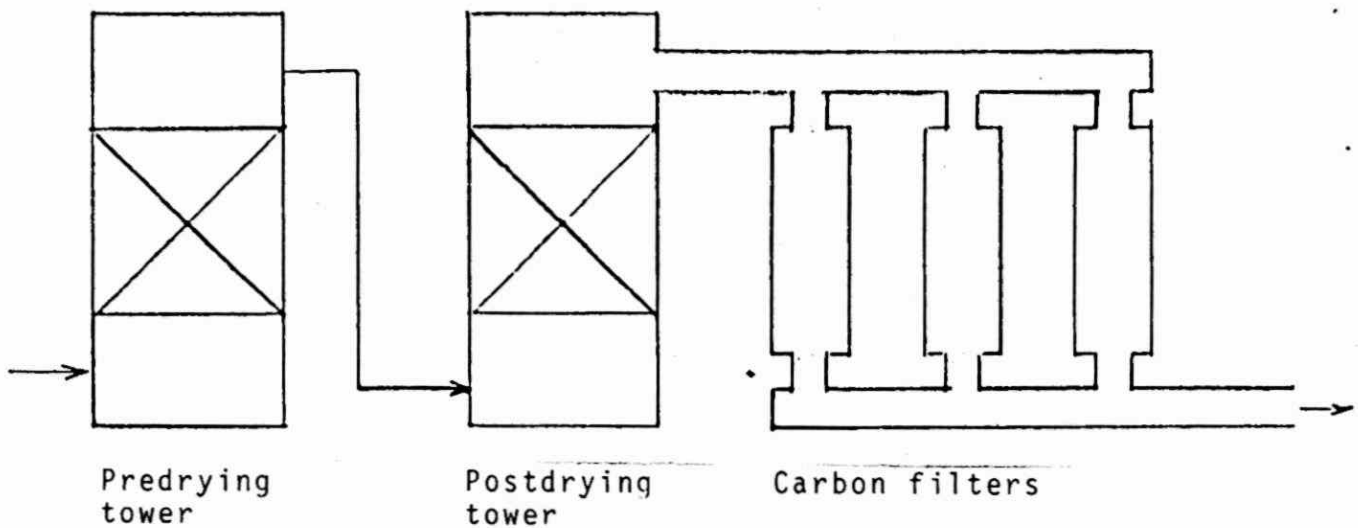
Fig. 4

SELENIUM FILTER



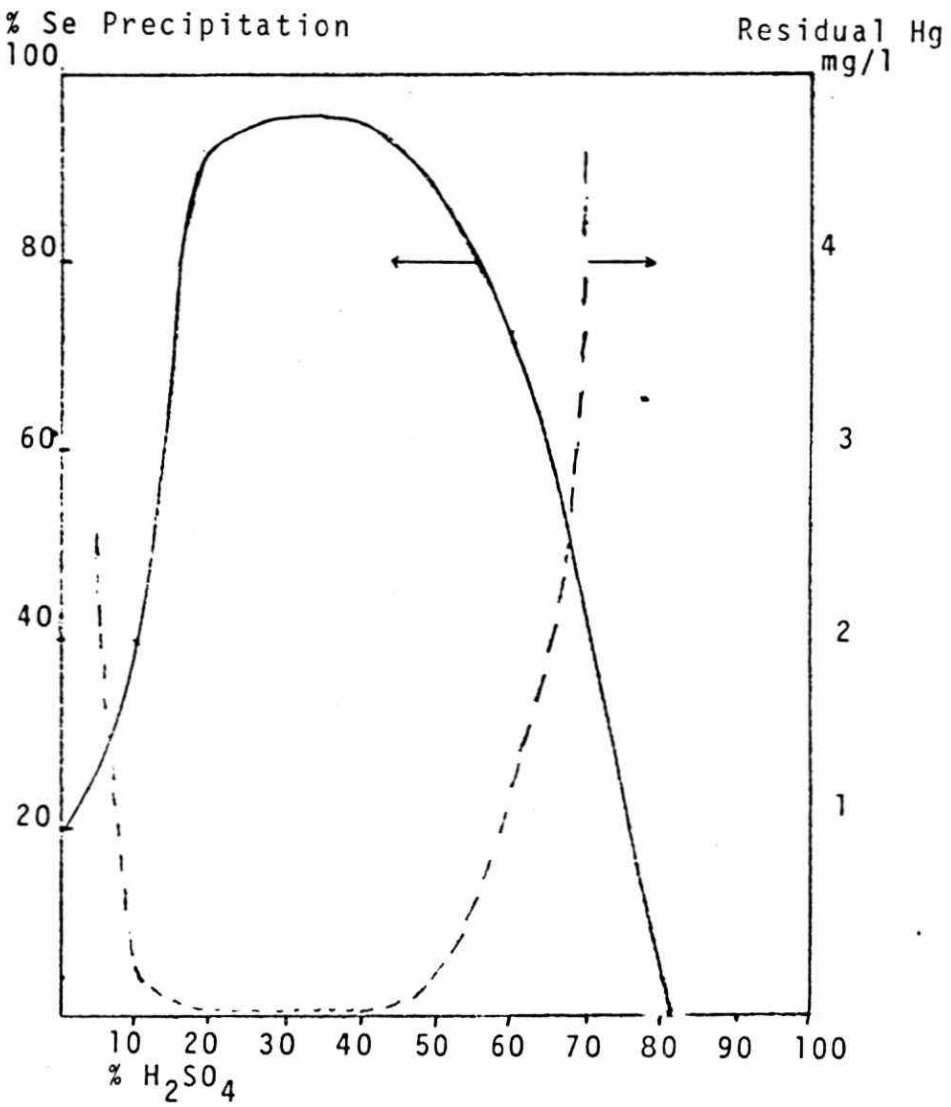
PICTURE 5

CARBON FILTER FOR SEPARATION OF HG



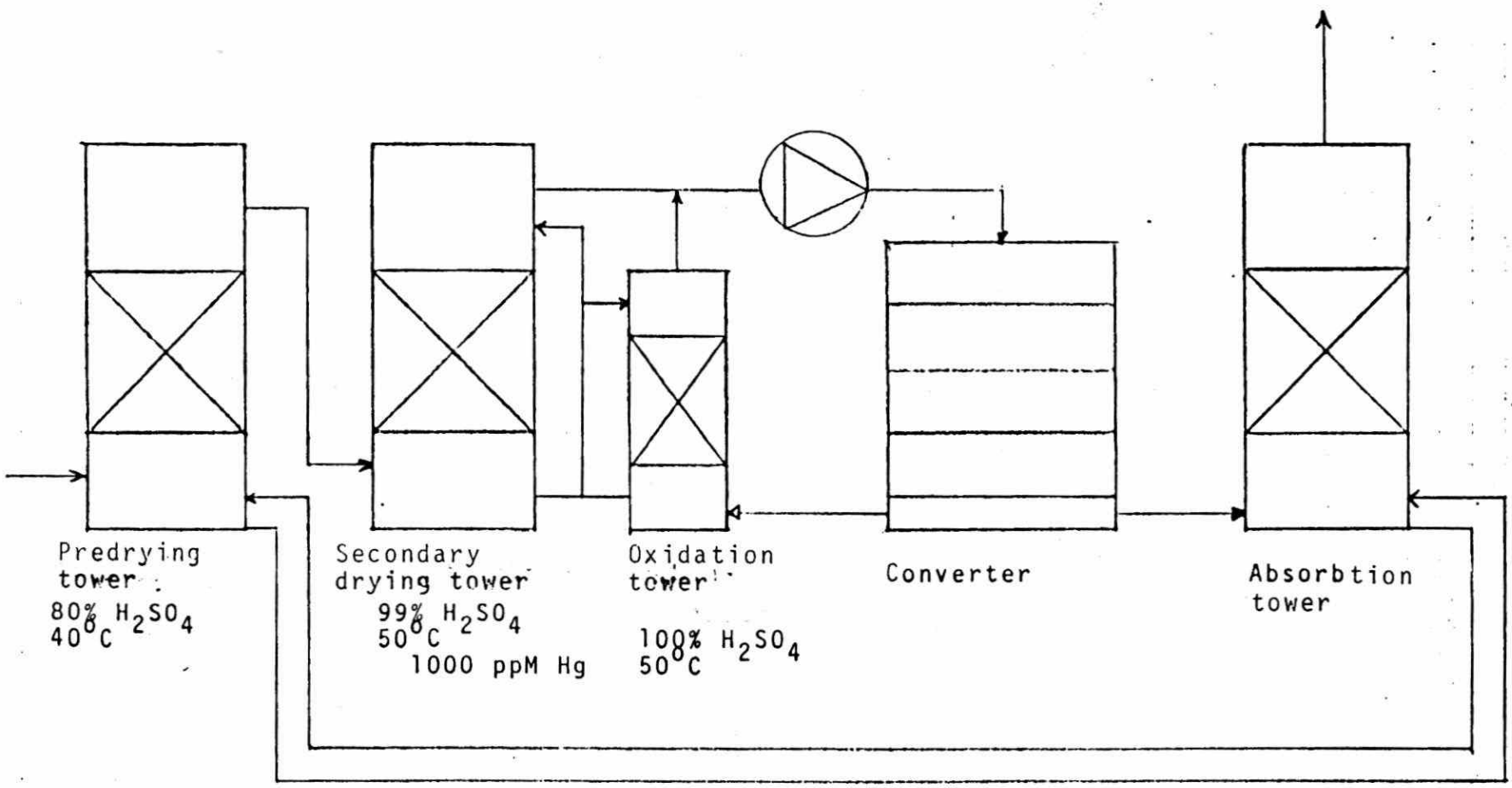
PICTURE 6

SOLUBILITY OF SE AND HG IN SULPHURIC ACID



PICTURE 7

TWO STAGE GAS DRYING OF SO_2-GAS FOR SEPARATION OF MERCURY



PICTURE 8

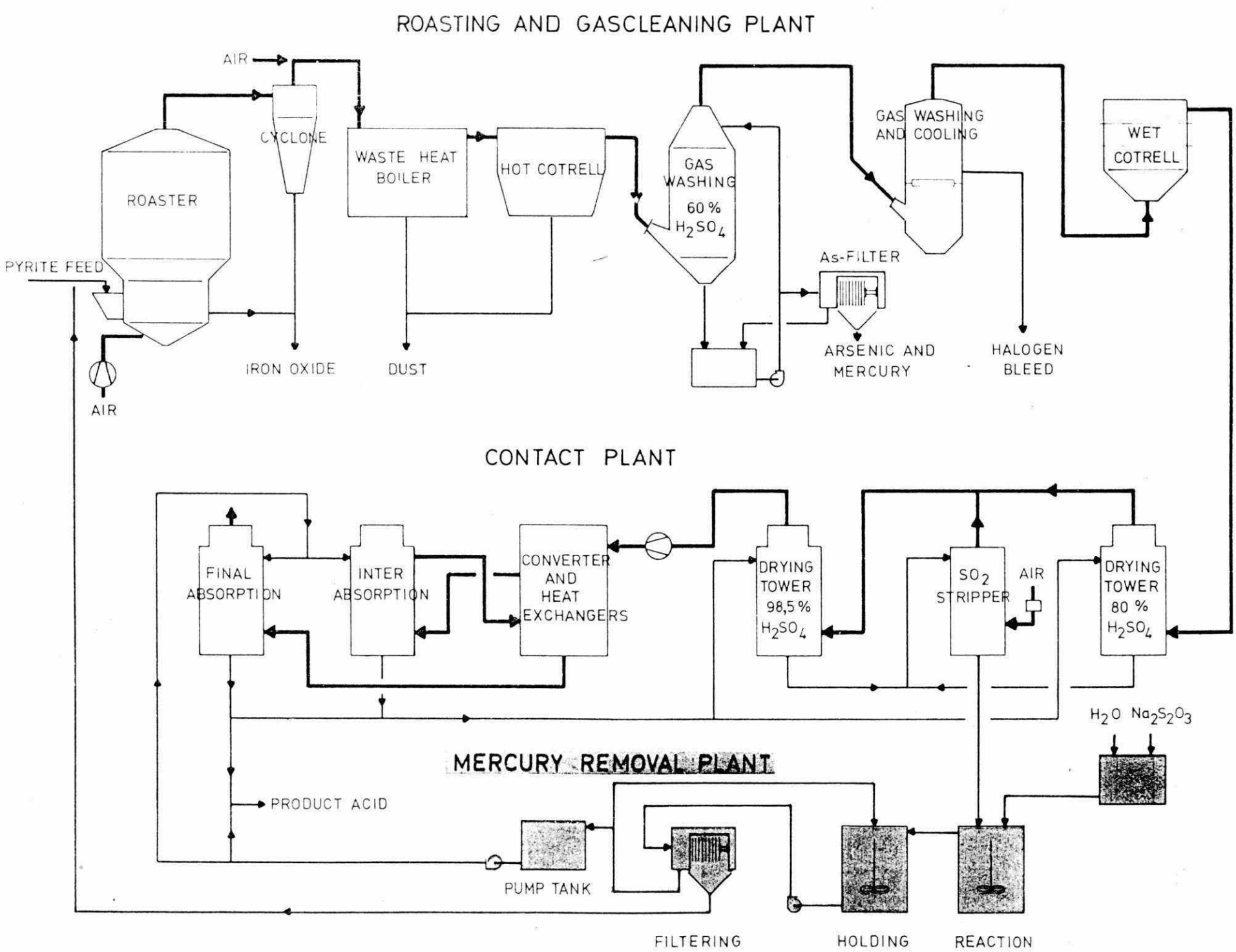

ROASTING AND GASCLEANING PLANT
AIR
CYCLONE
ROASTER
WASTE HEAT BOILER
HOT COTRELL
GAS WASHING 60 % H_2SO_4
GAS WASHING AND COOLING
WET COTRELL
As-FILTER
PYRITE FEED
IRON OXIDE
DUST
ARSENIC AND MERCURY
HALOGEN BLEED
AIR
CONTACT PLANT
FINAL ABSORPTION
INTER ABSORPTION
CONVERTER AND HEAT EXCHANGERS
DRYING TOWER 98,5 % H_2SO_4
SO_2 STRIPPER
AIR
DRYING TOWER 80 % H_2SO_4
H_2O $Na_2S_2O_3$
MERCURY REMOVAL PLANT
PRODUCT ACID
PUMP TANK
FILTERING
HOLDING
REACTION

FIGURE 9

BOLIDENS DRY GAS CLEANING PROCESS

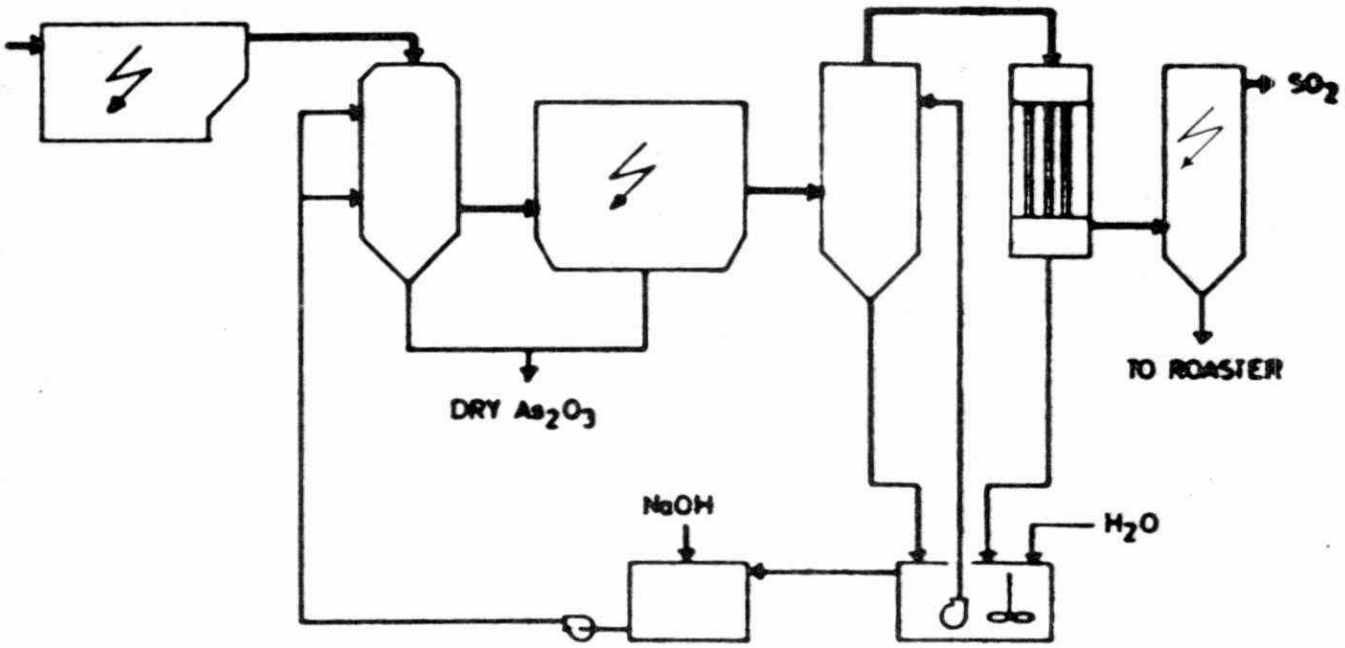


FIGURE 10

BOLIDENS WET GAS CLEANING PROCESS

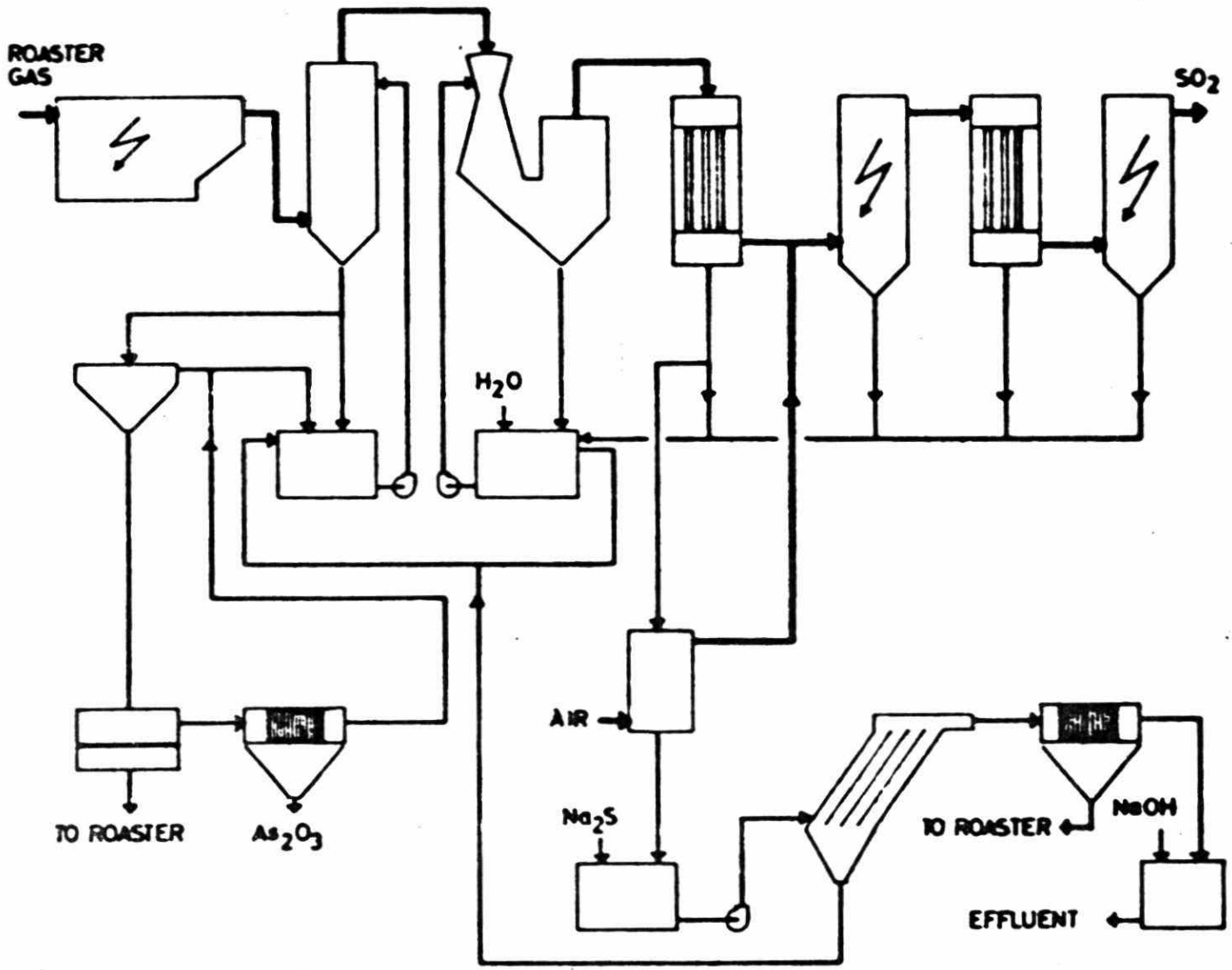


FIGURE 11

FUGITIVE DUST CONTROL IN IRON & STEEL PLANTS

by
Bruce A. Steiner, Manager, Environmental Engineering, Armco Inc., Middletown, Ohio

Introduction

The 1970 Clean Air Act set into motion a regulatory and administrative system designed to achieve clean air throughout the United States by July of 1975. As that date arrived and passed, however, with many areas of the country still exceeding ambient air standards for total suspended particulate (TSP) matter, it became apparent that traditional control strategies aimed primarily at large industrial process sources had failed to address much of the problem. As the legislative debate waged over what to do next, evidence mounted that fugitive dust sources were significant contributors to the particulate nonattainment problem. In spite of that increasing evidence, regulatory attention was directed primarily toward process fugitive emssion sources.

In late 1977 and early 1978, Armco had begun to assemble data and information which supported the position that controlling fugitive dust sources would be more effective and less costly than controlling process fugitive particulate emission sources. Methods for estimating emissions of fugitive dust sources had been developed, and the application of these methods at Armco's Middletown (Ohio) Works revealed that over 60% of the plant's particulate emissions evolved from such open dust sources. Further studies of TSP ambient air data in the area indicated that impacts from open dust sources were significantly greater than those from process related sources. For example, during periods of extended snow cover when open dust source emissions were mitigated by natural causes, ambient air TSP concentrations were considerably improved. On the other hand, during extended periods of major process shutdowns, no significant ambient air improvements were detected.

The emerging Bubble Concept appeared to represent a means by which fugitive dust sources could be controlled as an alternative to process fugitive emissions. However, EPA concerns over the ability to quantify and to model open dust source emissions prevented their acceptance of a proposed alternative without a demonstration that air quality standards would be met. As a consequence, Armco committed to implement a comprehensive fugitive dust control program at the Middletown Works.

The Middletown Program

The Middletown fugitive dust control plan consisted of a seven-point program with the following elements:

1. Reduction of plant vehicular traffic by installing plant perimeter parking and locker room facilities and establishing a busing program for employees and contractors.

2. Paving of unpaved roads, parking lots, and staging areas and installation of new paved roads to improve traffic flow where appropriate.

3. Cleaning of paved areas with daily use of mobile vacuum-type road sweepers and water spray trucks.

4. Treatment of unpaved surfaces with water and dust suppressant solutions.

5. Reduction of bare areas exposed to wind by planting of vegetation.

6. Surface treatment of storage piles with fixed or a mobile spray equipment to minimize windblown emissions.

7. Installation of an ambient air monitoring network to gauge progress and effects of the program.

Details of this plan have been described in previous papers.

The key to assessing the impacts of the control program was the deployment of the monitoring system, which became operational in August of 1979. A total of 16 monitoring sites, 6 of which were Armco-operated, were collecting data for all or part of the year preceding the complete implementation of the fugitive dust control program (Figure 1). The network provided an important data base that allowed comparison of data before and after control, albeit on a relatively short-term basis. Longer-term data has been collected at nine permanent monitoring sites.

The total cost of implementing this program was about $6 million. It was estimated that annual operating costs would be about $1.25 million. By contrast, control of process fugitive emissions from the open hearth furnaces, basic oxygen shop, and blast furnace casthouse were estimated to require an initial investment of $20 million and an annual operating cost of $2.5 million. Emission reductions from open dust sources were estimated to be six times that of the process fugitive controls.

Results of the Middletown Program

The effects of the program over the long-term are shown in Figures 2 through 4, where annual geometric means are displayed for each of the three Middletown area stations for which long-term data is available. The Reeds Yard station (Site 1 in Figure 1) is an Armco plant perimeter downwind station which would be expected to be most influenced by control of plant fugitive dust sources. Until late 1979, an agency station designated East End was effectively collocated with Armco's Reed Yard station and was the principal reason for the area being designated nonattainment for TSP. At the Reeds Yard site the period since 1980 shows an average annual geometric mean of 83 micrograms per cubic meter compared to 180 micrograms per cubic meter in the five years preceding 1980. The Verity School (Site 8 in Figure 1) and Hook Field (Site 7 in Figure 1) stations, are farther from the plant site and would not be expected to be influenced significantly by the fugitive dust control program. Nevertheless, reductions in the post-1980 period are 14 micrograms per cubic meter (21%) and 13 micrograms per cubic meter (20%) for Verity and Hook, respectively, compared to the period

1975 through 1979. Although production at this plant varied over the 10-year period, the maximum annual production occurred in 1978, and the minimum annual production (1980) was never less than 71% of the maximum. For reference purposes, production in 1983 was 91% of the 1978 level.

Quarterly geometric means from a number of additional monitoring sites from August 1979, a year before implementing the program, through the first quarter of 1984, are shown in Figures 5 through 11. Table I displays the average of quarterly geometric means for pre- and post-control periods. Although there are large seasonal fluctuations, as shown in Figures 5 through 11, the general downward trends are evident at nearly all stations. Impacts are greatest at those stations near the plant and downwind, i.e., those that would be expected to be most influenced by a fugitive dust control program. Moreover, these reductions were accomplished at significantly higher average plant production levels and under comparable meteorological conditions.

Two of the Middletown stations, SOS and Lefferson, were equipped with various size fractionating samplers. Results of various particle size fractions measured before and after implementation of controls are shown in Table II. At SOS, the upwind site generally considered to be a background station, relatively small changes are observed for any of the size fractions. However, at Lefferson, the downwind site, where a fugitive dust control plan would be expected to have greater impact, reductions of fine fractions as well as coarse fractions are observed.

The Ashland Program

Based upon the successful demonstration of the Middletown program and EPA's approval of the plan in March of 1981, efforts were undertaken to implement similar programs at other Armco plants. Faced with added control requirements for basic oxygen shop and blast furnace casthouse emissions at the Ashland (Kentucky) Works, a fugitive dust control program was proposed and was implemented at Ashland in early 1983.

The Ashland plan consisted of the following elements:

1. Paving of unpaved roads and parking lots.

2. Cleaning of paved areas with daily use of mobile vacuum-type road sweepers and water spray trucks.

3. Treatment of unpaved surfaces with water and dust suppressant solutions.

4. Installation of an ambient air monitoring network to gauge progress and effects of the program.

The monitoring system was made operational in July of 1981, about two years prior to the full implementation of the fugitive dust control program at the Ashland Works. Five Armco monitoring stations were installed at plant perimeter locations. Data were also being collected at six other Kentucky and Ohio control agency monitors in the vicinity (Figure 12).

The situation at the Ashland Works differed markedly from that at Middletown on several counts. Meteorology and terrain are much more important factors which influence air movements and the effect of plant emissions on ambient air quality. The configuration of the plant with respect to topographic features made it more difficult to site monitors and locations which truly represent ambient air. Moreover, potential fugitive dust emission reductions were less than Middletown because there was much less plant traffic, fewer miles of roads, and fewer opportunities for storage pile spray systems and vegetative plantings. Significant plant construction activities during this period also complicates the analysis. Furthermore, a more diverse industrial base, as well as significant changes in that base during the evaluation period, make the cause and effect relationship for a single plant's fugitive dust control plan less clear than for the Middletown case.

Results of the Ashland Program

A comparison of Ashland area ambient air data for Armco and agency monitors before and arter the full implementation of the program is shown in Tables III and IV. Table III shows results for the full data set. Table IV shows results for comparable seasons before and after control. Conclusions are more difficult to draw for Ashland than for Middletown not only because of the factors described above but also because less than one year of post-control data is available and seasonal or meteorological factors may be important considerations. Nevertheless, TSP concentrations appear to be down significantly at the Armco stations and the nearby agency Riverview site. Little change is observed at agency stations which are more distant from the plant and which are unlikely to be influenced by the plant's fugitive dust control program. Plant production was up slightly in the post-control period as shown.

The Ashland monitoring network also includes two sites equipped with size fractionating samplers. Table V shows results before and after controls for various size fractions at the two sites, designated West and East. As with the Middletown results, reductions are seen in both the coarse and fine fractions. In contrast to Middletown, however, there is no clear upwind and downwind station at Ashland because of the effects of complex terrain and meteorological factors.

Summary and Conclusions

Armco has implemented comprehensive fugitive dust control programs at two major integrated iron and steel plants as alternatives to more costly and less effective process fugitive emission controls. Significant improvements in TSP ambient air quality have been demonstrated in the vicinity of both plants. These improvements were obtained with less capital and operating costs, with less energy and in less time than process fugitive emission controls. Moreover, improvements are observed not only in TSP concentrations but also in smaller particle size fractions, which suggests that fugitive dust control programs will continue to be important as ambient air standards shift from TSP to inhalable particulate.

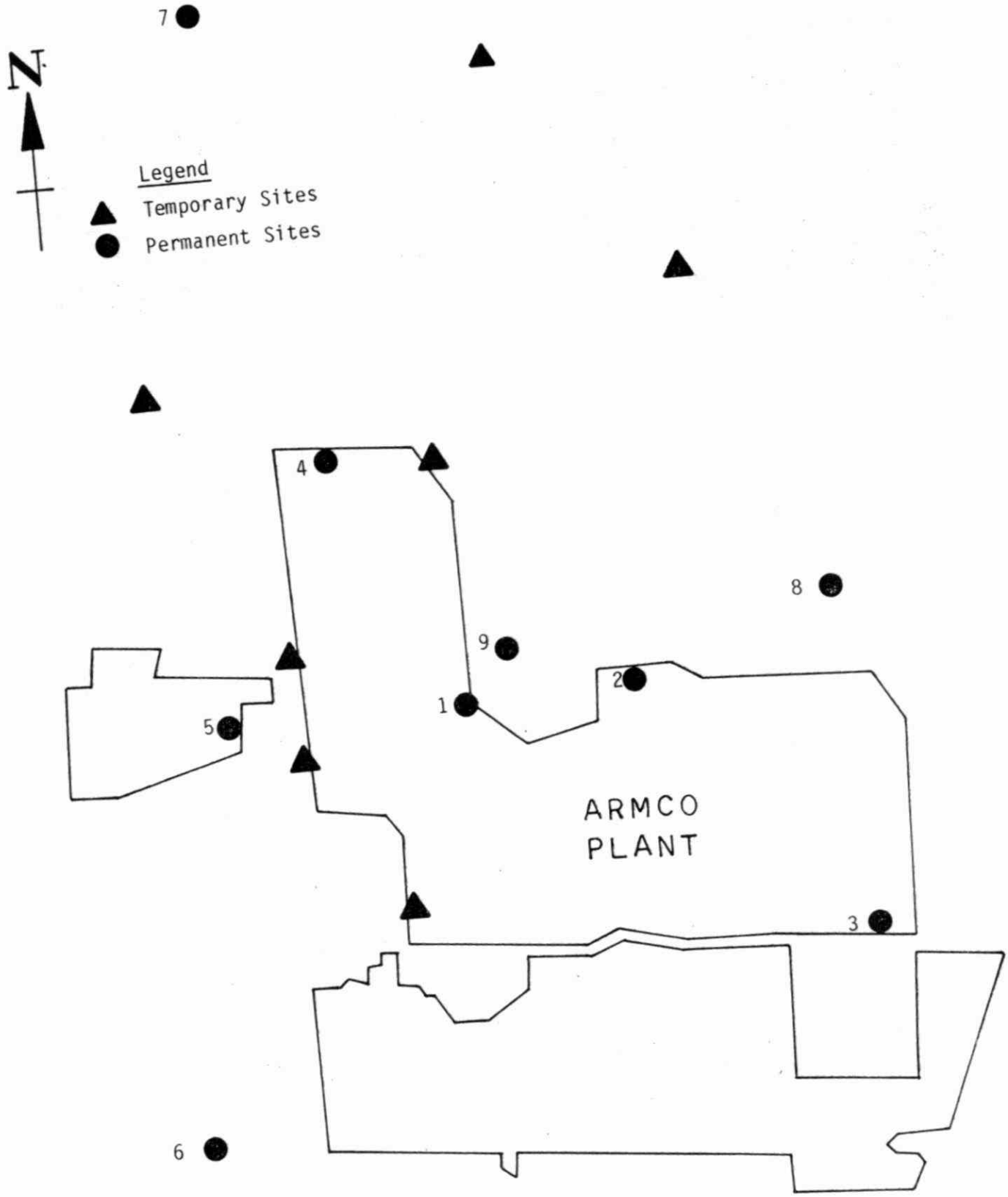


Figure 1. Middletown Area TSP Monitors

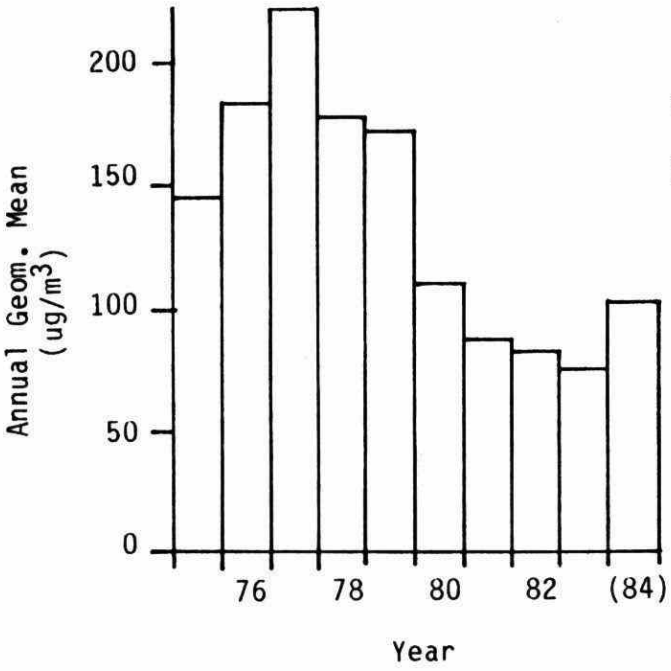


FIGURE 2

Reeds Yard TSP

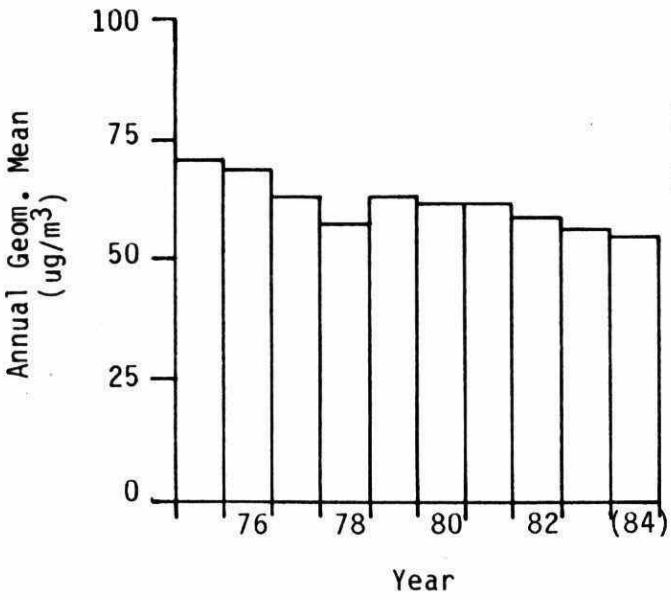


FIGURE 3

Hook Field TSP

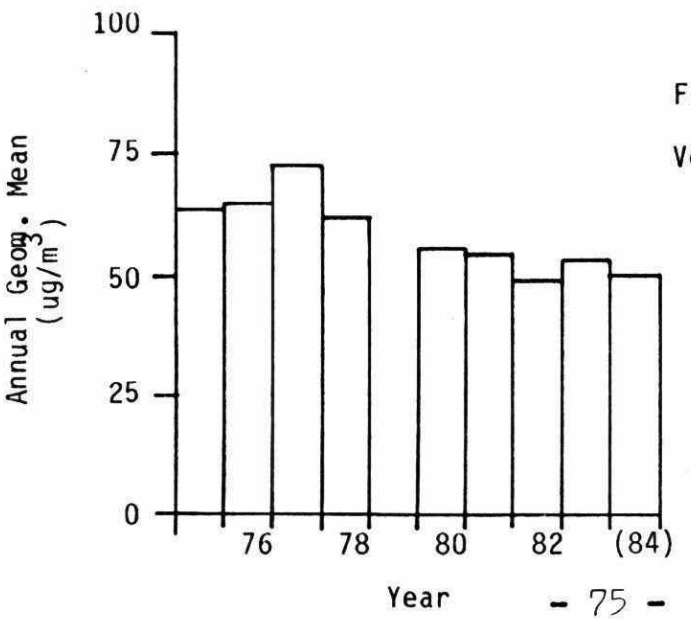


FIGURE 4

Verity School TSP

FIGURE 5

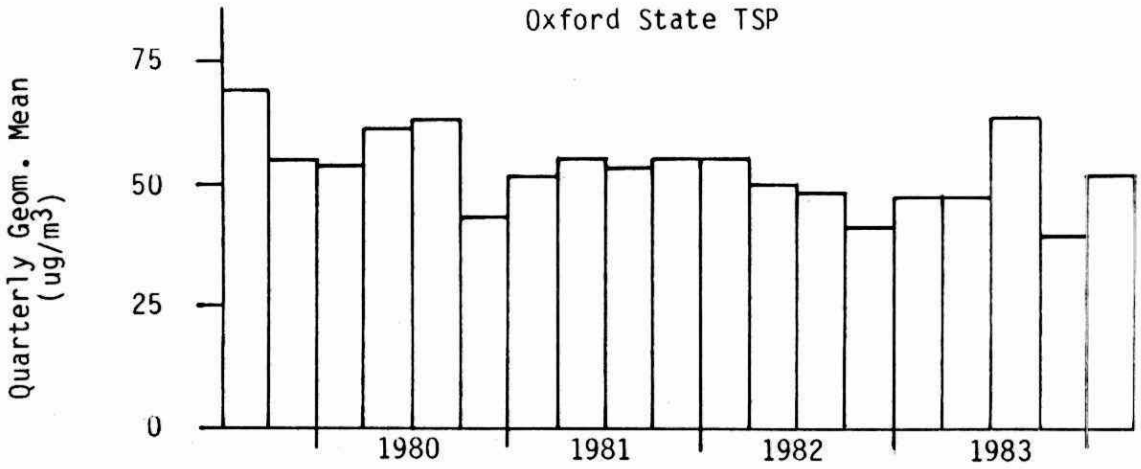


FIGURE 6

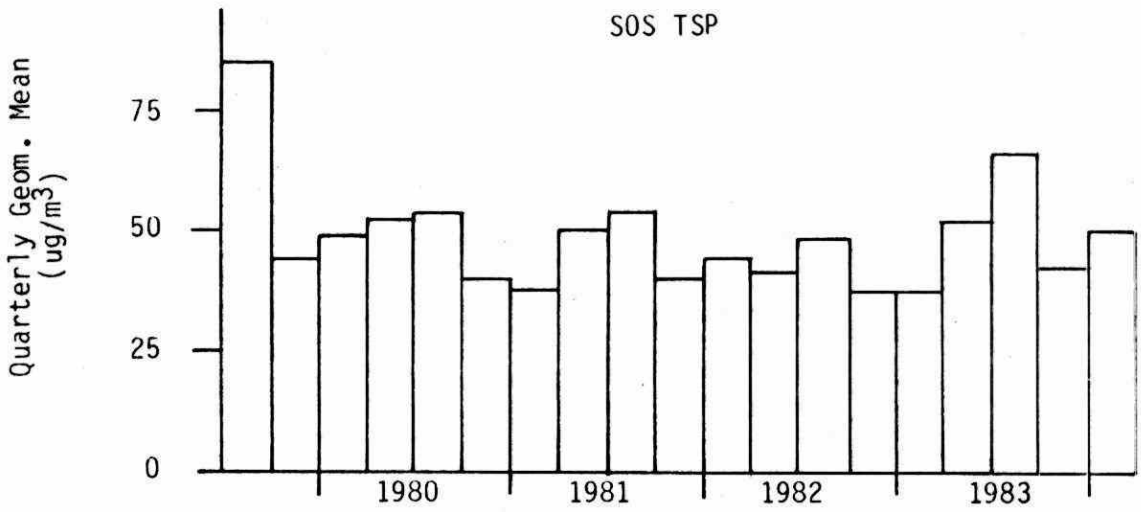


FIGURE 7

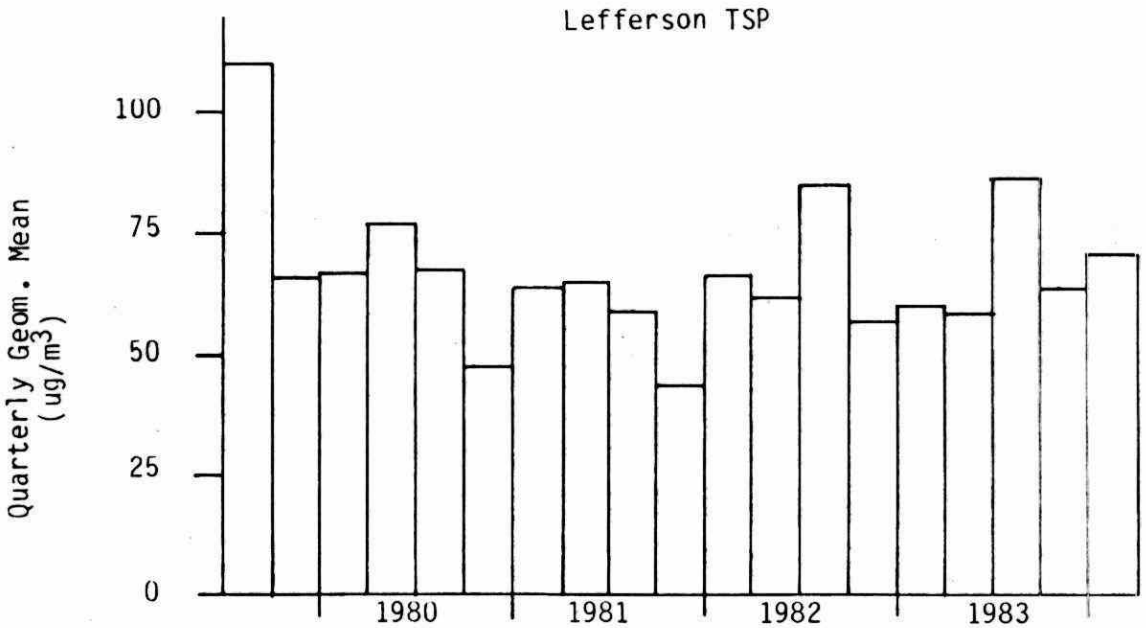


FIGURE 8

Main Gate TSP

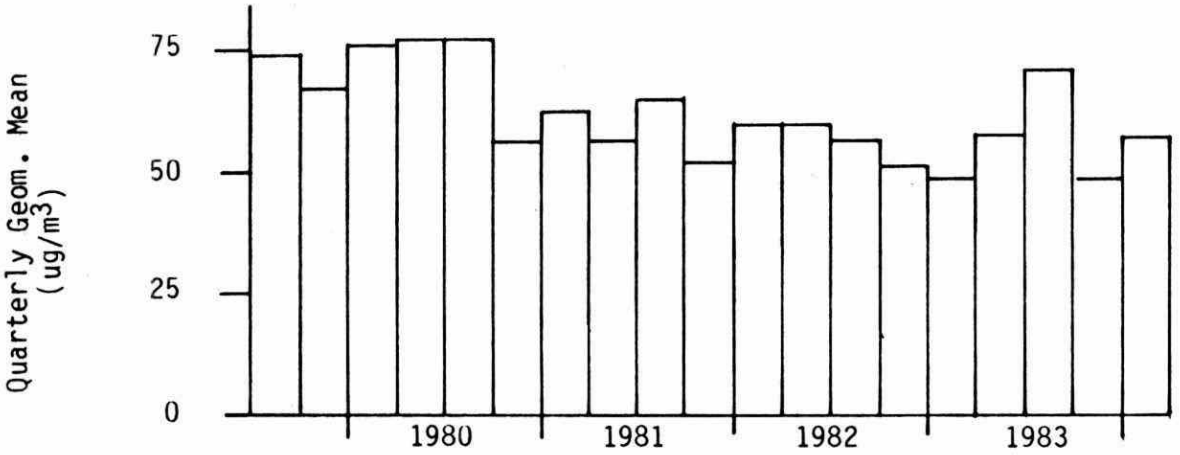


FIGURE 9

Reeds Yard TSP

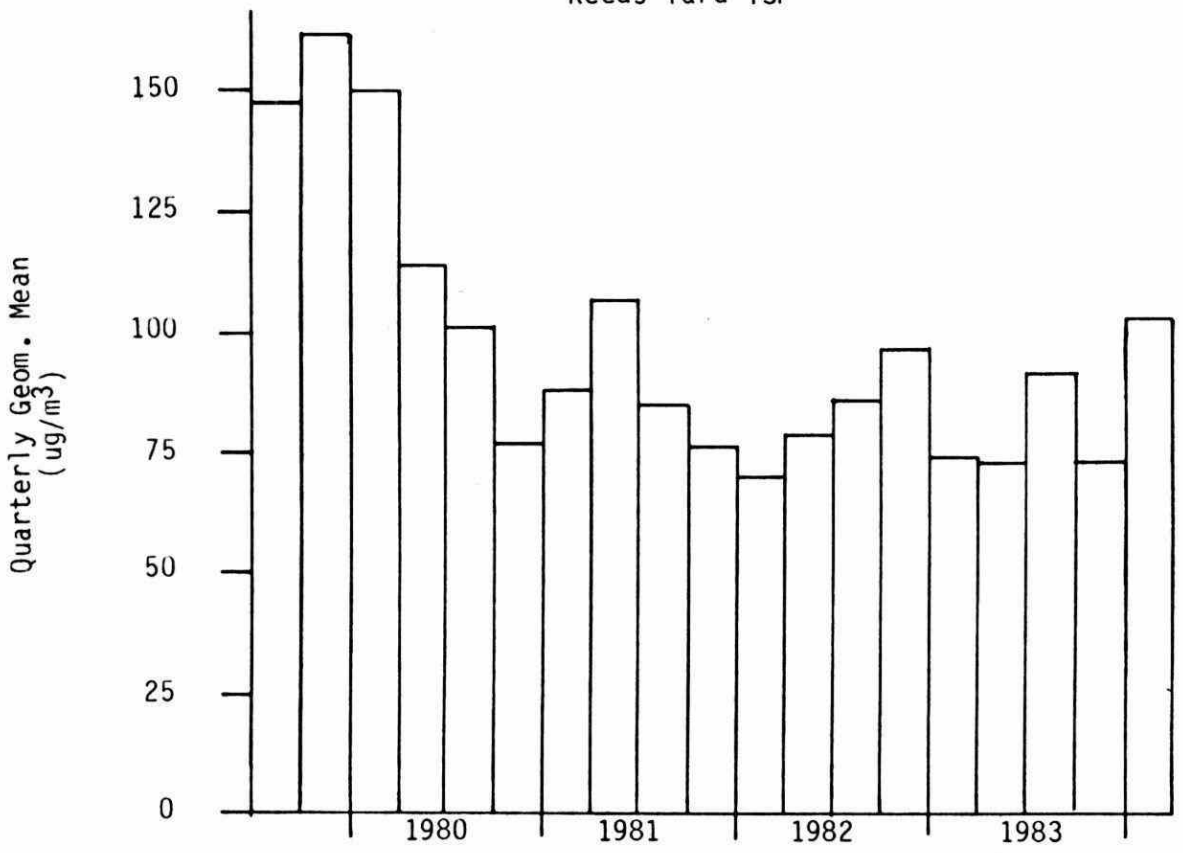


FIGURE 10

Srepco TSP

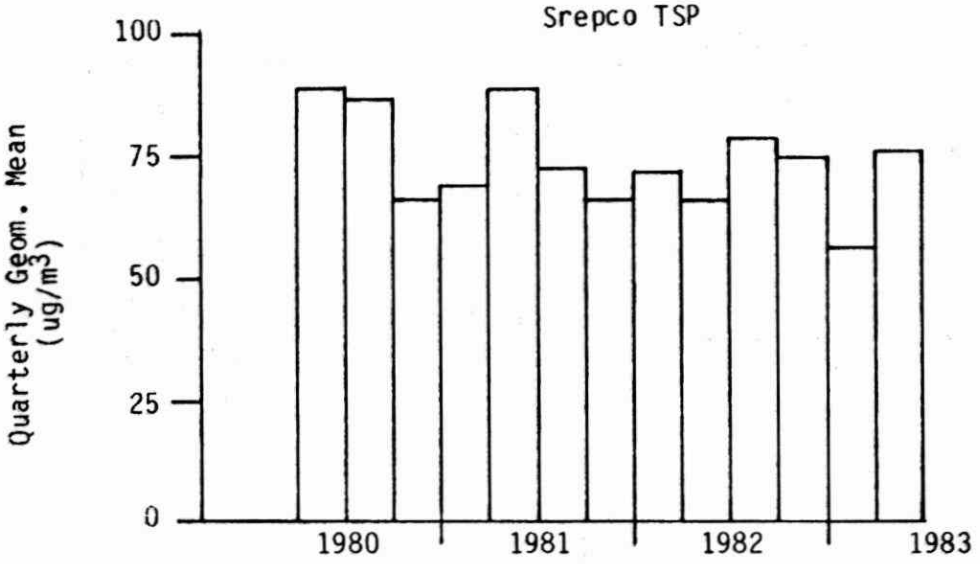


FIGURE 11

Hook Field TSP

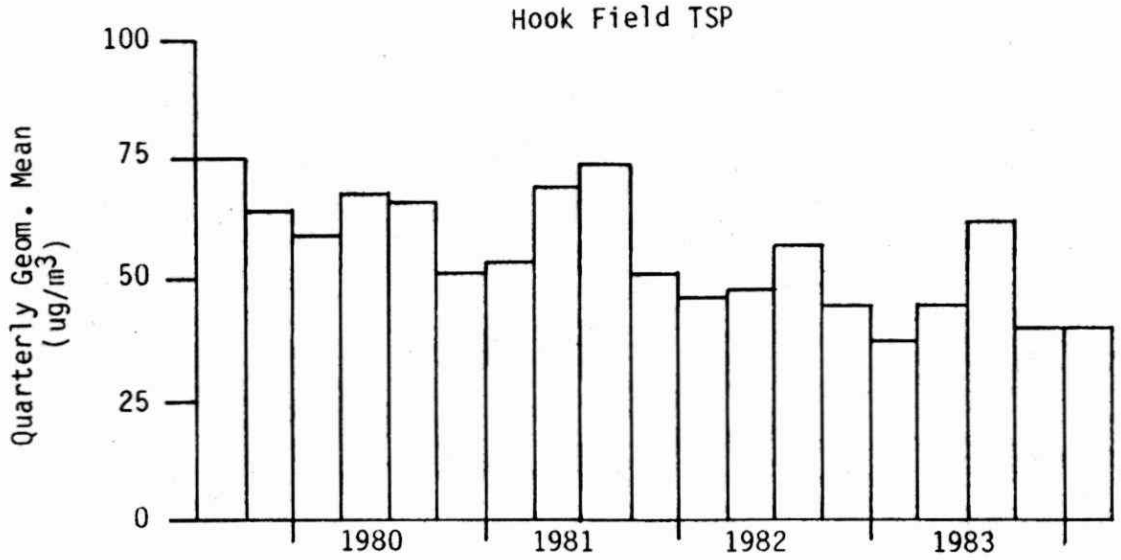
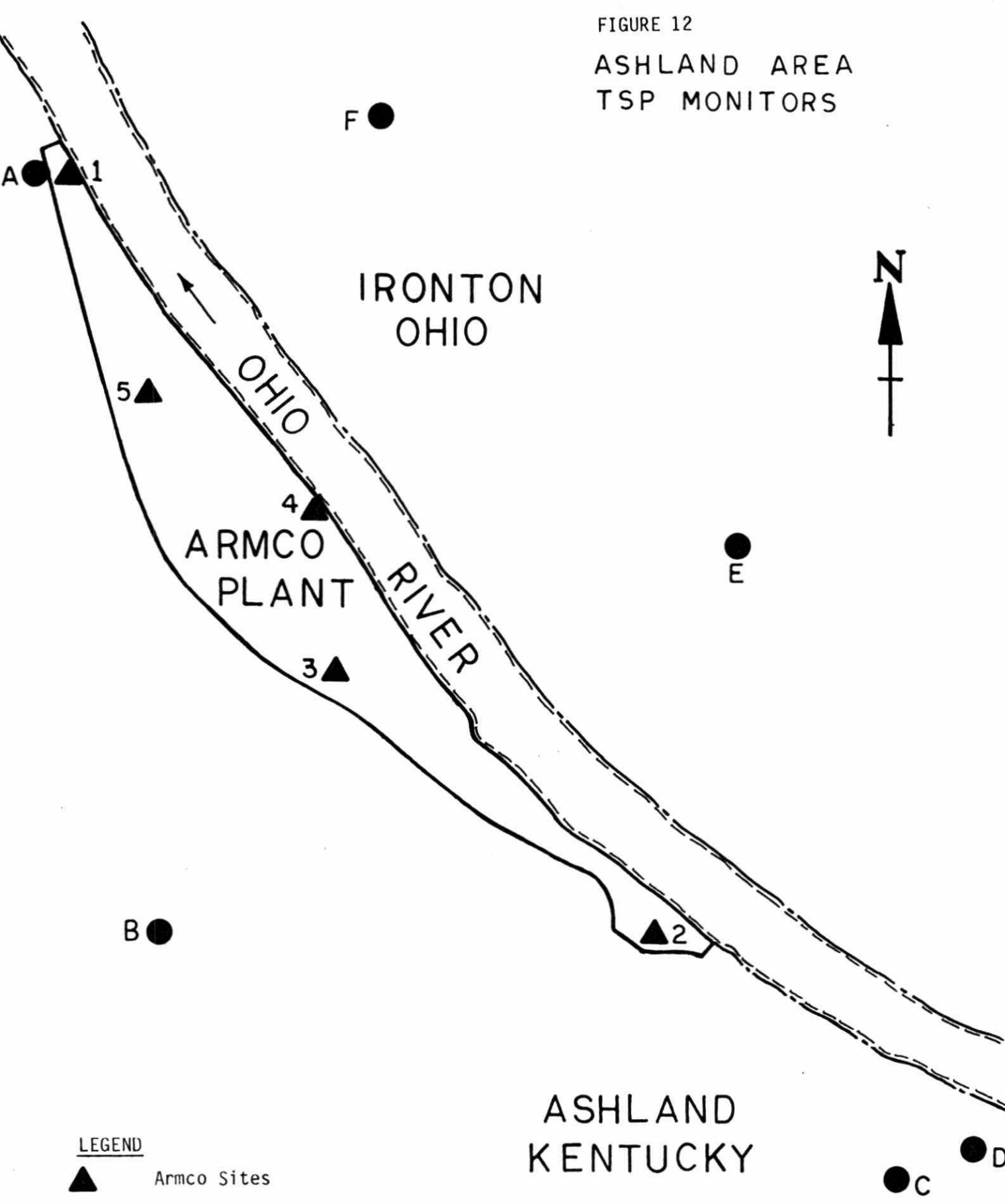


FIGURE 12

ASHLAND AREA
TSP MONITORS



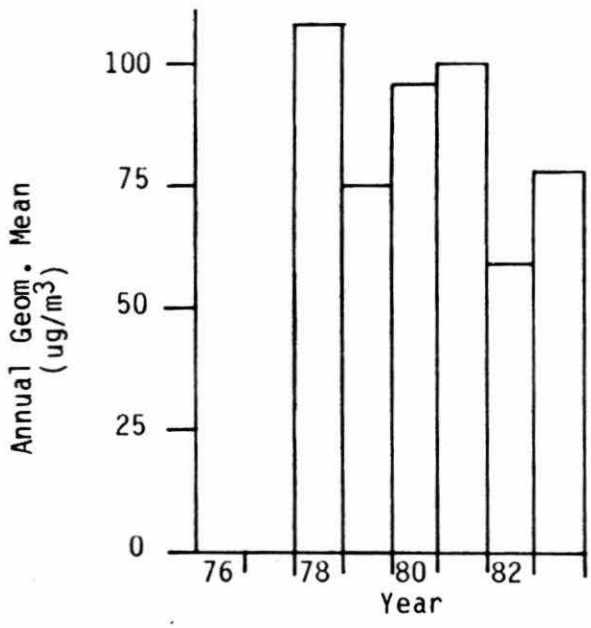


FIGURE 13

Front TSP

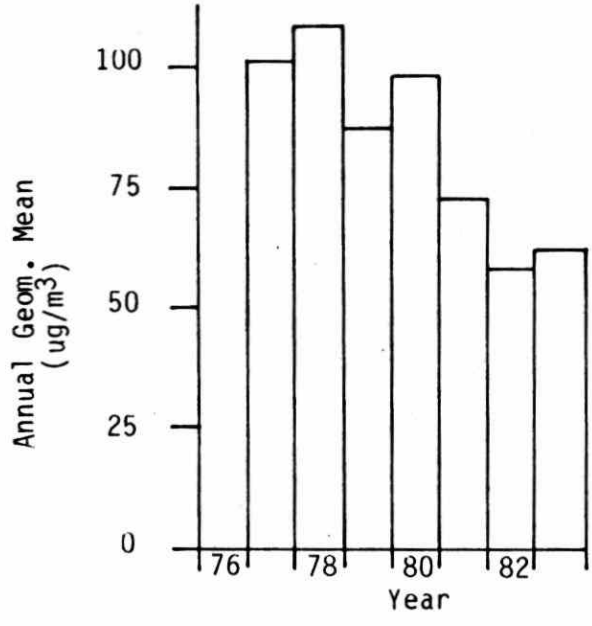


FIGURE 14

Coal Grove TSP

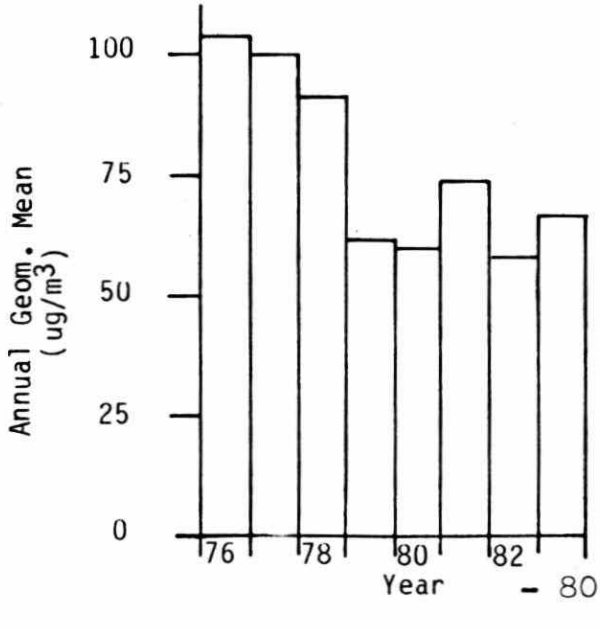


FIGURE 15

9th St. TSP

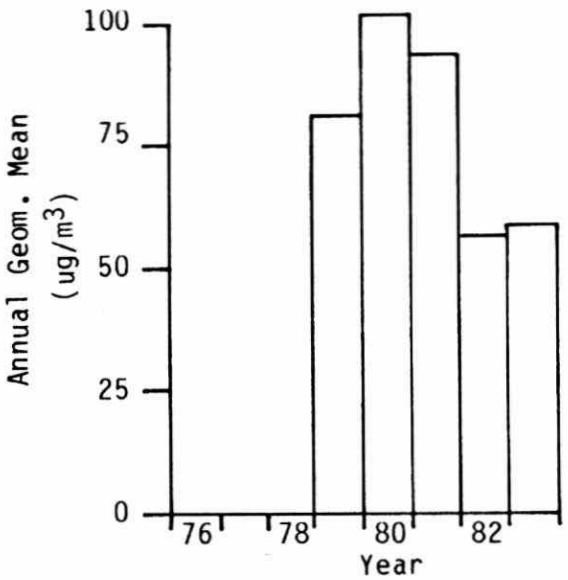


FIGURE 16

Riverview TSP

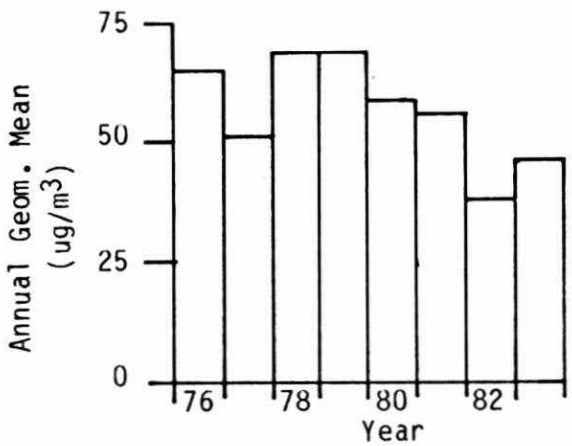


FIGURE 17

Hood TSP

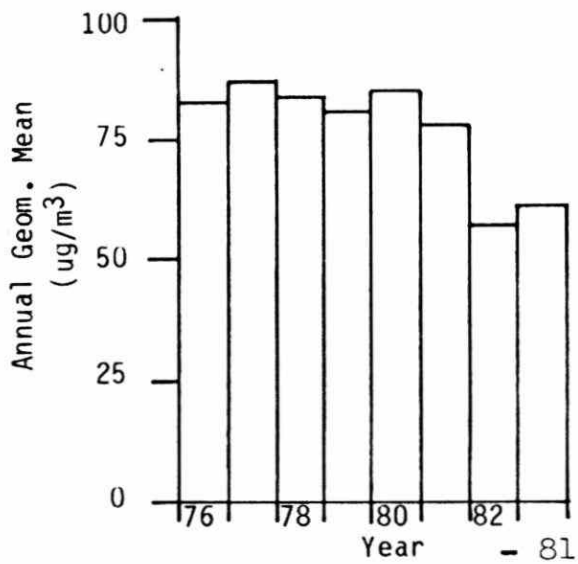


FIGURE 18

Carter TSP

TABLE I

MIDDLETOWN CONTROL PROGRAM EFFECTS

Station	Avg. Quarterly Geom. Mean TSP (ug/m^3) Before Control (3Q79-2Q80)	After Control (4Q80-1Q84)	% Change
1. Reeds Yard	143	84	-41
2. Lefferson	80	64	-20
3. Oxford State	60	50	-17
4. Main Gate	74	57	-23
5. Coil Paint	66*	63	- 5
6. SOS	58	46	-21
7. Hook Field	66	51	-21
8. Verity School	66*	52*	-21
9. Srepco	89*	72*	-19
Avg. Production (T/Mo.)	160,780	213,774	+33

*Data not available for entire period indicated.

TABLE II

MIDDLETOWN CONTROL PROGRAM EFFECTS

FOR VARIOUS PARTICLE SIZE FRACTIONS

Station & Fraction	Arithmetic Mean (ug/m^3) Before Control (Aug 79 - Jul 80)	After Control (Aug 80 - Mar 84)	Change
SOS			
TSP	53	52	- 1
<2.5 um	19	20	+ 1
2.5-15 um	12	13	+ 1
<15 um	31	33	+ 2
<10 um	27*	30	+ 3
Lefferson			
TSP	87	71	-16
<2.5 um	26	24	- 2
2.5-15 um	25	23	- 2
<15 um	51	47	- 4
<10 um	40*	37	- 3

*Estimated using a ratio of PM10/PM15 of 0.88 for SOS and 0.80 for Lefferson.

TABLE III

ASHLAND CONTROL PROGRAM EFFECTS

Station	Arithmetic Mean TSP (ug/m^3) Before Control (Jul 81-Jul 83)	After Control (Aug 83-Dec 83)	% Change
1. West	65	57	-12
2. East	80	70	-12
3. South	162	102	-37
4. North	97	97	0
5. Southwest	148	114	-23
A. Riverview	74	76	+ 3
B. Hood	49	51	+ 4
C. Carter	69	71	+ 1
D. Front	86	90	+ 5
E. Coal Grove	67	72	+ 7
F. S. 9th Street	67	73	+ 9
Avg. Production (T/Mo.)	117,000	124,000	+ 6

TABLE IV

ASHLAND CONTROL PROGRAM EFFECTS

SEASONALLY ADJUSTED

Station	Arithmetic Mean TSP (ug/m^3) Before Control (Aug-Dec/81 & 82)	After Control (Aug-Dec/1983)	% Change
1. West	71	57	-20
2. East	83	70	-16
3. South	177	102	-42
4. North	103	97	- 6
5. Northwest	160	114	-28
A. Riverview	86	76	-12
B. Hood	49	51	+ 4
C. Carter	69	71	+ 3
D. Front	95	90	- 5
E. Coal Grove	67	72	+ 7
F. S. 9th Street	68	73	+ 7
Avg. Production (T/Mo.)	118,000	124,000	+ 5

TABLE V

ASHLAND CONTROL PROGRAM EFFECTS

FOR VARIOUS PARTICLE SIZE FRACTIONS

Station & Fraction	Arithmetic Mean (ug/m^3) Before Control (Aug-Dec/81 & 82)	After Control (Aug-Dec/1983)	Change
West			
TSP	71	57	-14
<2.5 um	25	20	- 5
2.5-15 um	28	25	- 3
<15 um	53	45	- 8
<10 um*	39	34	- 5
East			
TSP	83	70	-13
<2.5 um	31	31	0
2.5-15 um	33	21	-12
<15 um	64	52	-12
<10 um*	47	39	- 8

*Calculated from relationship developed for Middletown:

PM10 = 0.70 (PM15) + 2.3 [n = 88; R^2 = 0.74]

THE UNITED KINGDOM
AIR POLLUTION CONTROL POLICY AT THE CROSSROADS

by

M.F. Tunnicliffe, Deputy Chief Industrial Air Pollution Inspector, Health and Safety Executive, London, England

In the long development of air pollution control policy in the United Kingdom two main and distinctive strands can be discerned. These are the primacy of local rather than central control, and the disinclination to legislate for fixed air pollution limit values, or standards as they are often called. It is because both of these strands of policy are now coming into opposition with supranational developments that I have chosen to describe them to you today, as a contribution to this wide-ranging Conference in the bi-centenary year of the Province of Ontario. From your historical position in relation to the United Kingdom and also from your geographical and socio-economic connection with the United States of America you may be well placed to gauge the import of what I have to say on these subjects and to assess the relevance to your own situation.

Air pollution has been described as a social evil, in that it is caused by nearly everyone as a consequence of social activity, and is suffered by nearly everyone. Yet historically it has always been perceived in the United Kingdom as being mainly a problem of locality, affecting say a particular valley or estuary, or a township, or the neighbourhood of a particular factory, and with the public reaction to it being similarly dependent upon locality. What was acceptable, or at least accepted with resignation, in the industrialised districts of a town was offensive to and vigorously opposed by the inhabitants of the more genteel districts, less dependent upon industry for their income.

So, from the beginning of our legislation for air pollution control the intent has been to provide powers to the local authorities, the towns and cities and rural districts, for them to be able to take action against air pollution to the extent that they judged it desirable to do so having regard to their own circumstances and their own priorities. This strand of policy continues today. The Clean Air Act of 1956, a major piece of social legislation which followed the London smog disaster of 1952, gave powers to local authorities to take action against coal smoke, whether from industrial, commercial or domestic premises, and the exercise of these powers very soon banished from our towns the smoke and dirt that had disfigured them for over a century. But no central government direction was exercised upon the local authorities, and the rate of progress was entirely left to them. Even today a few authorities, mainly in the coal mining regions, have taken little or no action, and central government has hesitated to bring in default powers.

You will know though that there is also a central government Inspectorate responsible for supervising air pollution controls on the technically more difficult industrial sources, and which would not at first sight correspond with this philosophy of local control. However, more than three-quarters of the Industrial Air Pollution Inspectorate are locally based, living and working in the districts allotted to them, with delegated responsibility and authority to take their own decisions, to be sensitive to local issues and contentions, and to cooperate with their local authorities on matters of joint concern. The Chief Inspector and his headquarters staff do not direct the field staff in matters of detail, and moreover the Inspectorate is not a direct instrument of central government policy.

As a further sign of the local committment of this central Inspectorate, the annual reports of each District Inspector, describing the activities of the year in a frank and open manner, are made available locally by the Health and Safety Executive to whoever may be interested.

The second strand of policy that I identified was the comparative absence, in the United Kingdom legislation, of statutory emission limits or of air quality standards. Many other countries by contrast have an array of such standards, and even the less-developed countries seem to begin their endeavours in industrial air pollution control by adopting air quality standards, but often without apparent means of enforcement.

The development of air pollution controls in the United Kingdom has been more pragmatically-based, by which I mean that solutions have been sought and devised for problems as they have emerged and been identified. The Clean Air Act of 1956, already mentioned, is an example. It was addressed to the coal smoke problem at a point in time when the evil had been finally and dramatically displayed and public tolerance exceeded. An earlier example is the Alkali Act of 1863 and its successor Acts, brought into being by outcry about the air pollution caused by the emerging heavy chemicals industry, and incidentally bringing about the formation of the present Inspectorate. The Alkali Act is now being replaced by equivalent provisions of the Health and Safety at Work Act.

The noteworthy feature of these Acts is that rather than concentrating upon emission limit values the emphasis is upon the actions to be taken. They require polluters to install and use and maintain appropriate means, characteristically "the best practicable means", as specified by the control authority. There is need to obtain uniformity of treatment across the country and within industries, and so performance criteria are given wherever it is appropriate to do so.
For industrial premises under local authority control

the Clean Air Acts provide limits for smoke, grit and dust which have statutory force, but for the industrial process operations which are under the Industrial Air Pollution Inspectorate the criteria are set by the Inspectorate and do not themselves have force of law. They are expressed as "presumptive limits", which can indicate that the best practicable means are being used, or conversely be taken as evidence that they are not being used. However, and I shall return to this point later, these presumptive emission limits are only a part of the control requirement on any particular industrial process. A great deal more is involved in setting the total requirement for new plant, or for setting up-grading requirements for existing plant. All aspects of the process operation are brought into consideration. The technical control of the process itself, the suitability of the air pollution equipment, the provisions for maintaining performance and for monitoring the emissions, the required height of chimney for the final emission, are but examples. For each industry concerned, and after discussions with that industry, the total requirements are brought together in published Notes on Best Practicable Means, which are for the guidance both of inspectors and of industrial managements, but significantly are not legal documents in themselves.

It is on to this scene, which has worked well in the United Kingdom and produced remarkably good results, that the problems of long-range trans-frontier pollution effects, and the development of European Community legislation, now appear.

I do not intend at this Conference to address Canadians on the problems of "acid rain", or of Federal-Provincial relationships but I hope that you are by now appreciating how these aspects,

or their equivalents, are setting new dimensions for the control policies of the United Kingdom. We have a good record of environmental progress, though having started very much earlier than other countries in our control measures our overall rate of progress may seem slower. We also have a genuine desire not to offend our neighbours in Europe, and to take our part fully in European Community endeavours. But as you can see from my exposition so far it has not been our practice to formulate overall codes for the environment, aimed at covering all eventualities within a unified and comprehensive system of legislation, nor to address environmental problems that are more speculative rather than demonstrable and for which moreover the solutions are not immediately apparent.

We understand well and can appreciate the concern of our European partners about what they perceive as damage effects of trans-frontier air pollution, and which we might perceive ourselves were the wind to blow more often from an easterly direction. Having already reduced our sulphur dioxide emissions substantially, and ratified the European Convention that seeks such reduction, we support continued endeavour in this direction. What we are concerned most about now is how to reconcile our long-standing practices with the fixed emission limits being proposed by the European Commission.

The first and most obvious point of difficulty for us is that some European Community limits will fall to be implemented by our local authorities without allowing them their present degree of discretion. Also, it might become necessary for central

government to monitor the activity of the local authorities in implementing the emission limits in order that the central government can assure the European Commission of the extent of national compliance. The alternative to this might be a supranational inspectorate, but whatever course is taken there will be a radical shift of responsibility away from the local communities.

The second area of difficulty would be the subjugation of our emphasis upon the means of control to the over-riding statutory emission limit. I might illustrate this best by describing briefly how the Inspectorate operates. In the first instance it is not a force of detectives, having only the aim of finding offenders. If statutory emission limits were the only criterion teams of technicians taking emission measurements, or sealed continuous monitoring instruments, might be a sufficient, though expensive, means of enforcement. With the control requirements of "best practicable means" an Industrial Air Pollution Inspector in the United Kingdom has a much deeper and more demanding task. Together with his duty of approving the appropriate means to be used to limit and control emissions from new plant, the most important feature is the continuing regular inspection of operating processes, without giving prior warning to the management. On these inspections he will examine all aspects of the operations that are relevant to the control of emissions; how well is equipment being used; how well is it being maintained; how well does the management understand its obligations and how well is it instructing its staff in their duties. He conducts, in effect, an audit of the works on behalf of the public whom he serves; he makes recommendations,

based upon the experience of the Inspectorate and upon his own judgement of the situation, or he issues instructions. And he decides how long the works may safely be left to control its emissions before he inspects again.

All of this requires certain characteristics of the Inspector, and it has been our constant practice to recruit chemists or chemical engineers of graduate status and having held positions of responsibility in process industries.

There is as yet little sign that the European Commission understands this deeper nature of successful air pollution control practice. A fixed uniform limit, bearing only upon the main emission from a process, is a simple concept with obvious appeal to legislators. But it can be far too simple for the real world, and fail to provide satisfactory safeguards for the local neighbourhood against the whole range of mishaps and maloperations that can arise with industrial processes. A locally-based inspectorate, well-trained and respected by industry for its first-hand knowledge and experience, can achieve far more, and with less trauma and confrontation, than limits imposed from afar and without flexibility or adaptability for local circumstances.

Our task now, in the United Kingdom, is to find how we can retain the best features of our control system and adapt it to the wider responsibilities and requirements that our membership of the European Community brings to us. We are fully committed to this challenge, at all levels of government and we look forward confidently to successful resolution of all the apparent difficulties.

EFFECTS AND CONTROL OF PHYTOTOXIC POLLUTANTS IN ONTARIO

by Samuel N. Linzon, Ph.D. Manager, Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment Toronto

The Ontario Ministry of the Environment is responsible for the protection and conservation of the natural environment. The overall goal of the Ministry is to "achieve and maintain a quality of the environment - including air, water and land - that will protect human health and the ecosystem and will contribute to the well-being of the people of Ontario."

The control of air pollution in Ontario is based on the Environmental Protection Act, under which the Ministry of the Environment inspects and regulates all possible sources of air pollution. The Ministry conducts monitoring programs of air quality throughout the province, and establishes air quality criteria and standards to protect human health and the ecosystem. Surveys of vegetation effects are conducted in the vicinity of industries and all complaints from the public regarding suspected air pollution damage to crops, ornamentals and forests are investigated.

Air quality in Ontario has improved dramatically in the past 15 years, with significant reductions having been documented for suspended particulate matter, particulate lead, sulphur dioxide, and carbon monoxide. Much of this reduction can be attributed to industrial emission controls during the 1970's. For example, total suspended particulate matter decreased 32% over the 1971-1979 period, while reductions of 45%, 68%, and 57% occurred for particulate lead, sulphur dioxide and carbon monoxide, respectively, during this time period. In addition, decreases of approximately 20% have been found for ozone and nitrogen oxides.

The cost of control of air pollution emissions in Ontario since 1968 has been more than $3 billion. Industry, for the most part, voluntarily invested this money in order to achieve a quality of air that is acceptable for the well-being of the people of Ontario. At the same time that the environment has been enhanced, industry continued to expand.

To accomplish the above, Environment Ontario has promulgated regulations with regard to the quality of the air. Standards and desirable air quality criteria have been established for more than 100 contaminants. Ontario's air quality standards for several pollutants, including sulphur dioxide, ozone, and suspended particulate matter, are more stringent than those in several other jurisdictions including the United States.

The Ontario Ministry of the Environment is the only agency in Canada with a comprehensive phytotoxicology program. This group which is staffed by plant and forest pathologists, ecologists, and greenhouse specialists investigate suspected air pollution injury to vegetation, including forests, crops, fruit tree orchards, field crops, and ornamental plantings. The investigations are conducted both in rural and urban locations. Assessment surveys are conducted in the vicinity of about 70 industries in Ontario each year for the degree and extent of contamination and vegetation injury for industrial abatement purposes.

The Phytotoxicology group also investigates about 200 complaints from the public each year in which air pollution is suspected of causing damage to trees, crops and livestock. In the laboratory, collected vegetation samples are analyzed by pathological, histological and chemical techniques. From field observations and laboratory analyses the investigation determines whether the injury is caused by air pollutants or by other harmful agents such as disease, insects, adverse weather, poor nutrition or mismanagement. Where the diagnosis of the cause of the damage is shown to be due to air pollution the Ministry of the Environment's industrial abatement engineers are advised to take action to curtail the

emissions of the phytotoxic pollutants, and a three-member Board of Negotiation is provided with a report of the technical findings in the event it has to negotiate a settlement of a monetary claim made by the complainant against the offending source.

Assessment surveys are conducted also in the vicinity of proposed industries in order to document the pre-industrial endemic condition of vegetation and soil in the area. The surveys determine normal conditions for the area with respect to soil, vegetation, diseases, and insects, and then after start-up of the industry, resurveys are conducted to ensure that no adverse effects are occurring in the area as a result of industrial operations.

In addition to conducting field investigations, the Ontario Phytotoxicology group conducts experiments in the most modern, specially-built clean air greenhouses and growth chambers in North America on the dose-response effects of air pollutants on plant life in order to develop air quality criteria and standards for the protection of agriculture and forestry.

Dose-Response Effects of Air Pollutants on Plant Life

Air pollution injury to plants can be evident in various ways. Injury to foliage may become visible in a short time and take the form of necrotic lesions (dead tissue) or it can develop slowly and become manifest as a yellowing or chlorosis of the leaf. There may be a reduction in growth of various portions of a plant. Plants may be killed outright but they usually do not succumb until they have suffered injury perennially. Injury may not be visible externally with effects occurring sub-cellulary in cell membranes and chloroplasts. The plants may suffer physiologically due to an upset in the rate of photosynthesis, respiration or transpiration.

The soil may become contaminated by accumulated heavy metals which can reduce the growth and yield of crops. Forage plants

contaminated by pollutants can cause harmful effects to grazing animals. Acid rain has the potential to cause serious effects directly on trees and crops and indirectly through the leaching of essential nutrients from the soil and the solubilization of toxic elements as aluminum.

Sulphur Dioxide

Major sources of sulphur dioxide are coal burning operations, especially those providing electric power and space heating. Large quantities of sulphur dioxide can result also from the burning of petroleum fuels and the smelting of sulphur-containing ores.

Sulphur dioxide enters leaves mainly through the stomata. The toxicity of sulphur dioxide to the mesophyll cells of leaves is primarily due to its reducing properties. Leaf injury is classified as either acute or chronic. Acute injury is caused by absorption of high concentrations of sulphur dioxide in a relatively short time. This results in a rapid accumulation of sulphite which is toxic to the metabolic processes taking place in the mesophyll cells. Chronic injury is caused by long-term absorption of sulphur dioxide at sub-lethal concentrations. The sulphite formed is oxidized to sulphate at about the same rate that the gas is absorbed. When sulphate accumulates beyond a threshold value that the plant cells can tolerate, chronic injury occurs. It is estimated that sulphate is about 30 times less toxic than sulphite.

Different plant species and varieties and even individuals of the same species may vary considerably in their sensitivity or tolerance to sulphur dioxide. Vegetation in Ontario found to be sensitive to sulphur dioxide include alfalfa, barley, eastern white pine, white birch, white ash, trembling aspen, Chinese elm, Manitoba maple and Bracken fern.

Vegetation is most susceptible to sulphur dioxide during the active growth months of June, July and August. For acute foliar injury to occur, 0.25 parts per million (ppm) of sulphur dioxide for eight hours or 0.95 ppm for one hour usually must be present. These doses can be reduced by about 25 per cent if the environmental factors and growth stages of the plant are especially conducive to injury. Chronic effects have been documented on forest trees exposed to an annual average of about 0.02 ppm sulphur dioxide.

Fluorides

Fluorides may be discharged into the atmosphere from the combustion of coal; the production of brick, tile, enamel frit, ceramics, and glass; the manufacture of aluminum and steel; and the production of hydrofluoric acid, phosphate chemicals and fertilizers.

Sensitive vegetation may be injured when exposed for 24 hours to atmospheric concentrations of hydrogen fluoride of 1 part per billion (ppb). The amount of fluoride accumulated in plant tissues depends on the absorption capacity of the plant, and its sensitivity to fluorine and ambient air concentrations. High concentrations of fluoride may accumulate in leaves during the growing season while subjected to extremely low concentrations in the air. Bitternut hickory can concentrate up to 1,000 ppm fluoride in its leaves without showing any visible injury, whereas the sensitive gladiolus may exhibit leaf injury with less than 35 ppm fluoride.

Studies of plant species susceptibility to fluorides showed that pine, gladiolus, apricot, plum, grape, tulip, iris, St. Johnswort and sweet corn were most sensitive.

Atmospheric fluorides, by concentrating in foliage and directly injuring plants, pose a threat to the health of livestock. Forage crops may appear normal while actually containing high concentrations of fluoride.

Cattle, feeding on forage plants over an extended period of time, may develop the disease fluorosis if the fluoride content is in excess of 40 ppm. The symptoms of chronic fluorine toxicosis are mottled and abraded teeth, swollen periosteal (bone surface) tissue, lameness and, in severe cases, decreased appetite and milk production.

Ozone

Ozone is the main phytotoxicant in the Los Angeles type of oxidant smog now plaguing many urban areas. Automobile exhaust is the major contributor of the primary pollutants (nitrogen oxides and reactive hydrocarbons) in the photochemical reaction producing the secondary toxic pollutant.

Oxidant damage to plants was first observed in the Los Angeles area in 1944. A wide variety of plants are susceptible to oxidant damage. In southwestern Ontario, phytotoxicology surveys conducted annually have revealed the widespread occurrence of ozone injury on tobacco, tomato, potato, and white bean crops. Ozone causes a spotting, bleaching or chlorosis of upper leaf surfaces. Typical lesions are produced on sensitive plants by concentrations of ozone as low as 0.08 ppm for one hour.

In addition to visible injury, growth suppression may result from the effects of oxidants decreasing photosynthesis and changing cell membrane permeability. Yields of various crops are reduced if exposed to an average of 0.04 ppm of ozone over the growing season during daylight hours.

Heavy Metals and Trace Contaminants

Heavy metals and other trace contaminants can be deposited directly on vegetation or can accumulate in the soil and be taken up by

plants to cause deleterious effects. Some of these contaminants include nickel, lead, arsenic, cadmium, mercury, and boron. The hazards of soil contamination to humans are through the food chain. Crops grown in contaminated soils can take up the contaminants and then pass them on to animals and man.

For industrial abatement purposes, Phytotoxicology excessive levels in soil and vegetation have been established for 20 elements. These "excessive" levels of contaminants in soil and vegetation have been developed based on over 10 years of surveys and chemical analyses of samples collected in rural, urban, or industrial settings. A certain level of a contaminant is considered to be "excessive" if it is well above normal, compared to average levels of the element which might be found under natural background conditions. "Excessive" does not necessarily mean toxic, but is evidence of contamination above average normal levels and thus would indicate that a particular industry has contributed to the abnormal level found in soil or vegetation. The Phytotoxicology "excessive" level for contaminants is used as a guide to assist in the control of emissions from industries; however, it should be used in conjunction with other diagnostic information obtained through a thorough field investigation in the vicinity of the industrial source.

The following table lists the Phytotoxicology excessive levels for contaminants developed for Ontario.

PHYTOTOXICOLOGY EXCESSIVE LEVELS FOR CONTAMINANTS - 1982

	Concentration Considered Excessive (ppm, dry weight)	
Contaminant	*Vegetation (not washed foliage)*	*Surface Soil (0-5 cm)*
Aluminum	*400*	*-*
Antimony	*3*	*5*
Arsenic	*5*	*20*
Boron	*200*	*25 (1 HWS*)*
Cadmium	*5 (3 rural)*	*8 (5 rural)*
Chromium	*20 (10 rural)*	*125 (75 rural)*
Cobalt	*10*	*25*
Copper	*30*	*100*
Fluoride	*35*	*-*
Iron	*800*	*-*
Lead	*100 (50 rural)*	*600 (150 rural)*
Manganese	*500*	*1500*
Mercury	*0.3 (0.1 rural)*	*0.6 (0.3 rural)*
Molybdenum	*8*	*5*
Nickel	*25 (15 rural)*	*100 (70 rural)*
Selenium	*2*	*3*
Silver	*5*	*5*
Sodium	*600*	*-*
Vanadium	*10*	*150*
Zinc	*200*	*600 (300 rural)*

**HWS = hot water soluble*

Acid Rain

Acidic precipitation has the potential to cause serious widespread effects on terrestrial ecosystems in certain areas of the world. In experiments using simulated acidic precipitation, a number of adverse effects have been produced in soils and vegetation. The adverse soil effects include the leaching of basic cations such as magnesium and calcium; the mobilization of soil-bound metals such as aluminum and iron; and changes in biological activity such as nitrification. In vegetation, the adverse effects observed include leaf cuticular erosion, lesions on the leaves, leaching of nutrients and reduced nitrogen fixation. With vegetation, a paradox sometimes occurs, in that the nitrogenous portion of acidic precipitation can act as a fertilizer and stimulate plant growth. Effects on native soils such as leaching of calcium and magnesium and increases in aluminum in soil solution have been associated with high atmospheric sulphate loadings.

With respect to forest productivity, the excessive leaching of nutrients from the soil may result in impoverished tree growth. Studies conducted in Germany indicate that the increased mobilization of aluminum, caused by the reduction in soil pH by acidic precipitation may have toxic effects on tree roots. In the northeast U.S.A. the decline and death of red spruce forests in mountainous areas have been reported with acidic precipitation being implicated by some investigators as contributing to this syndrome. In Quebec and Ontario, sugar maple tree decline is currently being investigated in areas subject to high loadings of acidic deposition.

In agricultural areas, effects from acidic precipitation are not expected to pose as great a potential problem as in undisturbed forested areas, because of the continual addition of lime and fertilizer to soil in the practice of more intensive crop management.

Because of the potential threat that acidic precipitation poses to terrestrial ecosystems a program of monitoring, surveillance and experimentation is underway in Ontario by the Terrestrial Effects Working

Group of the Acidic Precipitation in Ontario Study (Ministry of the Environment). At the Ministry's Brampton Controlled Environment Facility indoor simulated acid precipitation chambers have been constructed that are capable of reproducing rain events with a specific duration, intensity and chemistry. Experiments to define vegetation injury symptomatology using the chambers are necessary to document and confirm suspected effects in nature. An outdoor mobile acid rain exclusion canopy system is located also at Brampton. This system covers tree seedlings or crops during ambient rain events while delivering acidic rain simulants to the plants. The use of such outdoor facilities more realistically simulates the environmental conditions under which trees or crops are grown and permits better estimates of crop dose-response effects due to acidic precipitation.

Application of Phytotoxicology Survey Results in Achieving Control of Industrial Emissions

The Ontario Ministry of the Environment has to its credit a number of accomplishments. The following are a few examples where results of Phytotoxicology surveys conducted in the vicinity of industries helped in the alleviation of pollution in the area.

The degree and extent of damage to forests in the Sudbury area caused by sulphur dioxide fumes emitted by nickel smelting industries were documented by the Ministry. On the basis of data on economic damage to forests and deteriorating air quality the nickel producing companies were served Control Orders in 1970 to curtail their emissions. The reductions in sulphur dioxide emissions have resulted in little or no acute damage occurring currently to vegetation in the Sudbury area. Further reductions in emissions have been ordered in a staged program to reduce the contribution of sulphur dioxide to acid rain.

During 1965 to 1967, 58 farmers in the vicinity of a superphosphate fertilizer manufacturer at Port Maitland were awarded by arbitration, compensation payments amounting to $271,244.00 for damage to livestock and crops caused by fluorides. In 1968, a Control Order was served to the industry by the Ministry, and the company installed air pollution control equipment. These measures led to large improvements in the area. Only a few fluoride-caused injuries were found in 1968 and claims from these growers were heard by the Board of Negotiation with a total of $2,300 recommended for payment. No monetary claims for damage were received in 1969, two were received in 1970, one in 1971 and none in the past 12 years.

The Phytotoxicology group documented in the early 1970's the first record in the world of the occurrence of visible injury on vegetation caused by airborne arsenic. Gold smelters in Northwestern Ontario were responsible for the emissions. Because of the finding of vegetation damage and toxic levels of arsenic in vegetation and soil in the area, the gold companies were served Control Orders to reduce their emissions of arsenic. The installation of pollution control equipment by the smelters has resulted in no arsenic injury to vegetation in the area since 1976.

The Phytotoxicology group successfully solved a problem in 1975 of the sudden occurrence of damage on ornamental trees on about 200 properties in a residential suburb of Toronto. Several industries are located in the area and the phytotoxicologists were asked to identify the contaminant that caused the injury and determine the industry that was responsible. A number of field surveys and laboratory examinations were conducted which diagnosed that the injurious effects were caused by an acute fumigation of hydrogen fluoride and that the source of the pollutant was a nearby oil refinery. The diagnosis was based primarily on the cellular damage caused to injured Scots pine needles. After the report was issued

the company accepted responsibility and compensated all claimants. The company was issued a Control Order to prevent the recurrence of high concentration fluoride fumigations, and no fluoride effects have been observed in the area since 1975.

Soil and vegetation surveys conducted by the Phytotoxicology Section in the vicinity of several secondary lead industries in Toronto showed that high levels of lead contamination occurred in neighboring residential areas. In cooperation with medical consultants from other agencies such as the Ministry of Labour, Toronto Board of Health and the University of Toronto, the high levels of lead in soil were correlated with elevated levels of lead in blood of some of the children living near the industries. The companies instituted measures to control the emissions of lead which have reduced fallout in the area. In addition, the recommendations of an Environmental Hearing Board were implemented, and soil with high levels of lead on about 50 residential properties were removed and replaced with uncontaminated top soil.

In addition to lead, the Phytotoxicology Section has documented the effects of several other heavy metals in the vicinity of industries in Ontario. Nickel and cobalt emissions from a nickel refinery have contaminated soil on several nearby farms resulting in crop injuries and yield declines that have been significant. The heavy metal fallout occurred over a period of several decades before the installation of pollution control devices by the company, and thus historical contamination of soil remains a persistent problem. Mercury emissions from a chlor-alkali plant have also contaminated soil and vegetables grown in neighboring residential gardens. Consultation is ongoing between industrial abatement engineers and company representatives to resolve these problems.

The Phytotoxicology Section determined that methane released from underground decomposing wastes at a large landfill site near Toronto was killing neighboring trees due to soil oxygen depletion and root

asphyxiation. A complex ventilating system was installed by the company which has alleviated the problem, and no tree damage is now occurring on neighboring properties.

In response to requests from an Indian Band on Cornwall Island, Phytotoxicology surveys documented extensive damage to vegetation and livestock in the early 1970's by emissions of fluorides from aluminum manufacturers located in New York State. The Phytotoxicology reports were used by New York State to impose control orders on the companies to reduce emissions of fluoride. As a result, the degree and extent of fluoride contamination of vegetation on Cornwall Island has been drastically reduced. In cooperation with the Canadian government, studies are continuing in order to assess current effects for use in pending lawsuits.

Through field studies and controlled environment experiments, the Phytotoxicology Section has provided data for use in the formulation of air quality criteria and standards for air contaminants. A number of air contaminants which are more toxic to vegetation than to human health at low concentrations include sulphur dioxide, ozone, hydrogen fluoride and ethylene. Air quality objectives for these contaminants established by Ontario or by the Canadian government have been dependent on scientific data provided by the Phytotoxicology Section.

The above account outlines some of the effects of phytotoxic pollutants and the controls placed on emissions to improve the quality of the air in Ontario. From industrial approvals, to the issuance of control orders, and the meeting of air quality criteria and standards, the work of the phytotoxicologists has been of immense value to the Ministry of the Environment in managing Ontario's air resources.

SESSION III – ENERGY FROM WASTE – INTRODUCTION

Chairman: D.A. McTavish, Director,
Southwestern Region,
Ontario Ministry of the Environment,
London, Ontario

The Honourable Philip Andrewes
Ontario Minister of Energy
Toronto, Ontario

C. Chisamore, Manager, Municipal Waste
Unit, Biomass/Energy from Waste Section,
Ontario Ministry of Energy, Toronto

T. Burrell, Consultant
Victor and Burrell Research Consultants,
Toronto, Ontario

Dr. D. Balsillie,
Director, Air Resources Branch,
Ontario Ministry of the Environment,
Toronto, Ontario

ENERGY FROM WASTE --
TACKLING TWO OF SOCIETY'S PROBLEMS AT ONCE

BY

THE HONOURABLE PHILIP ANDREWES
ONTARIO MINISTER OF ENERGY

I WISH TO THANK MR. WALTER GILES FOR THE OPPORTUNITY TO ADDRESS THE THIRTY-FIRST ONTARIO INDUSTRIAL WASTE CONFERENCE.

I AM HERE TODAY TO TALK TO YOU ABOUT THREE ITEMS THAT I BELIEVE WILL BE OF INTEREST: FIRST, INDUSTRIAL PRODUCTIVITY; SECOND, PUBLIC AND CORPORATE COMMITMENT; AND THIRD, NEW BUSINESS CHALLENGES.

BEFORE YOU THINK THAT I'VE BEEN INVITED TO THE WRONG CONFERENCE, LET ME ASSURE YOU THAT ENERGY FROM WASTE IS THE FOCUS OF MY REMARKS.

MANY DISCUSSIONS ON ENERGY FROM WASTE DEAL ONLY WITH THE DIRECT ENERGY AND ENVIRONMENTAL BENEFITS. AND YET, FOR THE BENEFITS TO BE FULLY REALIZED, WE HAVE TO SERIOUSLY THINK ABOUT, AND ACT UPON, THESE OTHER ISSUES.

LET'S FIRST TALK ABOUT ENERGY FROM WASTE AND PRODUCTIVITY. IN THE PROCESS OF TURNING PRIMARY RESOURCES INTO MANUFACTURED PRODUCTS, WE GENERATE WASTE -- LOTS OF IT. IT IS THE PRICE WE PAY FOR OUR INDUSTRIALIZED AND URBANIZED SOCIETY.

BUT IT IS A PRICE THAT IS TAKING TOO HIGH A TOLL.

THE HIGH COSTS OF RAW MATERIALS FOR MANUFACTURING AND THE DRAMATIC RISE IN ENERGY PRICES OVER THE PAST DECADE HAVE MADE US VERY CONSCIOUS OF THE COST OF TURNING PRIMARY RESOURCES INTO SECONDARY GOODS. THESE HIGH COSTS HAVE MADE US VERY AWARE OF THE NEED TO MINIMIZE WASTE IN ORDER TO REDUCE COSTS.

SUCH INCREASES HAVE CONTRIBUTED SIGNIFICANTLY TO THE DECLINE OF PRODUCTIVITY IN OUR MANUFACTURING BASE IN ONTARIO.

IN THE HIGHLY COMPETITIVE ENVIRONMENT IN WHICH ALL INDUSTRIES FIND THEMSELVES, DOING <u>SOMETHING</u> ABOUT THESE COSTS IS VITAL TO STAYING COMPETITIVE.

RECYCLING THE BY-PRODUCTS OF MANUFACTURING IS CATCHING ON. DEVELOPING MORE ENERGY-EFFICIENT PROCESSES IS ALSO GAINING GROUND. SO IS RECOVERING AND CONSERVING WASTE HEAT FROM THE MANUFACTURING PROCESS.

AN EXAMPLE OF THE LATTER THAT COMES TO MIND IS THE ST. LAWRENCE CEMENT COMPANY IN CLARKSON. THE COMPANY IS NOW USING SLAG FROM HAMILTON STEEL MILL OPERATIONS INSTEAD OF LIMESTONE IN ONE OF ITS KILNS TO PRODUCE CEMENT.

CEMENT PRODUCED FROM SLAG DOES NOT REQUIRE THE NORMALLY HIGH TEMPERATURES NEEDED FOR FIRING CEMENT PRODUCED FROM LIMESTONE.

WHAT THIS MEANS IS SIGNIFICANT COST AND ENERGY SAVINGS.

ST. LAWRENCE CEMENT ALSO SAW AN OPPORTUNITY TO USE HEAT RECOVERY, AND MOVED ON THAT, TOO. WASTE HEAT FROM THE LIMESTONE KILN IS NOW BEING USED TO DRY THE SLAG IN THE NEW OPERATION.

WHY IS ST. LAWRENCE CEMENT DOING THIS? FOR ONE VERY GOOD REASON: IT MAKES GOOD ECONOMIC SENSE. THE COMPANY WILL SAVE AN ESTIMATED $450,000 EACH YEAR AND ACHIEVE A THREE-YEAR PAYBACK ON A TOTAL INVESTMENT OF $1,165,000. THE FEDERAL AND PROVINCIAL GOVERNMENTS PROVIDED $88,000 EACH TOWARD THE COST OF THE PROJECT.

TRADING WASTES CAN ALSO MAKE SENSE. ONE INDUSTRY'S THROWAWAYS MAY BE ANOTHER INDUSTRY'S FEEDSTOCK. THE CANADIAN WASTE EXCHANGE, LOCATED AT THE ONTARIO RESEARCH FOUNDATION, IS HELPING TO MATCH UP THE TWO. FOR A ONE-YEAR PERIOD ENDING IN MAY OF THIS YEAR, APPROXIMATELY 214,000 TONS OF INDUSTRIAL WASTES WERE EXCHANGED. THIS DISPLACED MORE THAN SIX MILLION DOLLARS WORTH OF PRIMARY MATERIAL PURCHASES.

ST. LAWRENCE CEMENT AND THE WASTE EXCHANGE ARE ALSO TWO GOOD EXAMPLES OF MY SECOND TOPIC -- PUBLIC AND CORPORATE COMMITMENT.

WE HAVE A COMMITMENT TO MANAGE OUR WASTE IN WAYS WHICH WILL NOT LEAVE A LEGACY OF PROBLEMS FOR FUTURE GENERATIONS.

THE KEY ISSUE IS THIS: WHAT, REALISTICALLY, CAN BE DONE TO REDUCE LANDFILL REQUIREMENTS AND RECOVER THE IMPORTANT MATERIALS AND ENERGY COMPONENTS OF WASTE? HOW CAN WE MAKE A SIGNIFICANT DENT IN THE MORE THAN SIX MILLION TONNES OF GARBAGE WE NEED TO DISPOSE OF ANNUALLY IN ONTARIO?

THE ONTARIO GOVERNMENT BELIEVES THAT ENERGY FROM WASTE WILL HELP US SOLVE THIS DILEMMA. IN THIS REGARD, THE MINISTRY OF ENERGY IS WORKING CLOSELY WITH THE MINISTRY OF THE ENVIRONMENT TO DEVELOP ENERGY RECOVERY AS AN INTEGRAL PART OF THE FOUR R'S MY COLLEAGUE, ANDY BRANDT DISCUSSED YESTERDAY.

EVEN AFTER SEPARATION OF MATERIALS, 80 PER CENT OF WASTES REMAIN AND MUST BE DISPOSED OF.

IT IS IN SOCIETY'S BEST INTERESTS TO REDUCE LANDFILL VOLUMES WHILE STABILIZING THE COSTS OF DISPOSAL THROUGH THE RECOVERY OF THE RESOURCE VALUES IN WASTE.

ENERGY RECOVERY FROM WASTE WHICH CANNOT BE SEPARATED AT SOURCE MAKES SENSE, AND EXPERIENCES IN MANY PARTS OF THE WORLD PROVES THAT IT CAN WORK. THERE ARE MORE THAN 360 PLANTS BURNING 180,000 TONNES OF REFUSE PER DAY AROUND THE WORLD. CLEARLY, WE'VE GOT SOME CATCHING UP TO DO.

IT IS BECOMING MORE AND MORE DIFFICULT IN CERTAIN AREAS OF THE PROVINCE TO FIND LARGE AMOUNTS OF SPACE FOR LANDFILL SITES. CONTRAST THAT TO THE RELATIVELY SMALL SPACE NEEDED FOR AN ENERGY FROM WASTE PLANT, AND ONE CAN READILY SEE WHY THEY ARE AN ATTRACTIVE ALTERNATIVE FOR THAT REASON ALONE.

ANOTHER EQUALLY ATTRACTIVE REASON -- SQUEEZING VALUABLE ENERGY FROM THE THROWAWAYS OF BOTH INDUSTRY AND SOCIETY BRINGS ME TO MY THIRD TOPIC: BUSINESS CHALLENGES.

THE OBJECTIVE OF THE PROVINCE IS TO MAKE THESE PROJECTS COMMERCIALLY VIABLE, TO THE POINT WHERE VERY LITTLE GOVERNMENT ASSISTANCE WILL BE REQUIRED TO GET THEM STARTED AND TO KEEP THEM OPERATING. HOWEVER, THE ONTARIO GOVERNMENT RECOGNIZES THAT FINANCIAL SUPPORT IS REQUIRED TO HELP GET THE TECHNOLOGY OFF THE GROUND AND INTO THE MARKETPLACE.

MAKING ENERGY RECOVERY FROM WASTE A COMMERCIAL REALITY IS NO SMALL CHALLENGE. MUNICIPAL SOLID WASTE PROJECTS ARE COMPLICATED, REQUIRE LONG LEAD TIMES AND ARE COSTLY.

THERE ARE SEVERAL FACTORS THAT WILL LEAD TO COMMERICAL SUCCESS IN ENERGY FROM WASTE. NOW, TO BRIEFLY OUTLINE THESE FACTORS:

CUSTOMERS WHO PAY COMMERCIAL PRICES FOR STEAM AND POWER;

TIPPING FEES THAT REFLECT LONG-RUN COSTS EQUIVALENT TO LANDFILL REPLACEMENT AND;

A REALISTIC RETURN ON INVESTMENT FOR PRIVATE INVESTORS.

HOWEVER, LET'S NOT DISCOUNT THE PRINCIPAL RISK FACTORS, WHICH ARE:

FINDING SUITABLE PROPONENTS TO BUILD, OPERATE AND MANAGE THE FACILITIES;

COMPLEX INSTITUTIONAL AND BUSINESS ARRANGEMENTS;

ECONOMIC CLIMATE -- INTEREST RATES AND COMPETITION FOR SCARCE CAPITAL;

UNCERTAINTY IN FUTURE ENERGY PRICES.

IT IS NO COINCIDENCE THAT THESE FACTORS ARE PRECISELY THOSE NEEDED TO GET OIL AND GAS MEGAPROJECTS OFF THE GROUND.

THE MAIN DIFFERENCE IS IN THE ORDER OF THE MAGNITUDE. IN THE CASE OF OIL AND GAS MEGAPROJECTS, THE CAPITAL IS IN THE 20 TO 40 BILLION DOLLAR RANGE. IN THE CASE OF ENERGY FROM WASTE, INVESTMENTS WILL BE IN THE AREA OF 10 TO 100 HUNDRED MILLION DOLLARS.

THIS MAY SEEM SMALL BY COMPARISON, BUT IT WORKS OUT TO BE A GREAT DEAL WHEN IT CONCERNS CAPITAL AT THE MUNICIPAL LEVEL.

FISCAL RESTRAINT IS A LONG-TERM REALITY FOR THE PROVINCE AND THE MUNICIPALITIES. FINANCIAL RESPONSIBILITY MUST BE EXERCISED IN THE PLANNING, CONSTRUCTION AND OPERATION OF ENERGY FROM WASTE FACILITIES.

THE PROVINCE AND MUNICIPALITIES BY THEMSELVES CANNOT MAKE ENERGY FROM WASTE WORK. THE PRIVATE SECTOR MUST BE INVOLVED THROUGH A COMMITMENT OF CAPITAL, TECHNICAL EXPERTISE AND ON-SITE MANAGEMENT.

THESE FACILITIES MUST EVENTUALLY BE ABLE TO STAND ON THEIR OWN FINANCIAL MERITS.

THE POINT IS THIS: THERE ARE NO EASY ANSWERS, AND NO QUICK FIXES TO SOCIETY'S WASTE DISPOSAL AND ENERGY PROBLEMS.

DESPITE THE FACT THAT ENERGY FROM WASTE REPRESENTS A SIGNIFICANT BUSINESS CHALLENGE, THERE ARE A HOST OF ENCOURAGING ACTIVITIES TAKING PLACE IN ONTARIO. THE FORESTRY INDUSTRY HAS PRODUCED STEAM AND POWER FROM THEIR WASTES FOR YEARS. SEVERAL OTHER MAJOR INDUSTRIES, SUCH AS 3M, THE FORD MOTOR COMPANY, AND BF GOODRICH ARE ACTIVELY CONSIDERING ENERGY FROM WASTE FACILITIES.

THE TYPE OF WASTE VARIES: THEY COULD BE USING THEIR OWN IN-PLANT WASTE, INDUSTRIAL/COMMERCIAL WASTE FROM OTHER SOURCES AND EVEN RESIDENTIAL WASTE.

PERHAPS THE MOST PUBLICIZED PROJECT TO DATE IS THE PLANNED STATE-OF-ART ENERGY FROM WASTE FACILITY FOR LONDON VICTORIA HOSPITAL.

WHEN IN OPERATION, THE PLANT WILL PROCESS 270 TONNES A DAY, OR 80 PER CENT OF THAT CITY'S GARBAGE (POPULATION: 265,000), PLUS 30 TONNES OF DRY SEWAGE SLUDGE FROM THE CITY'S GREENWAY POLLUTION CONTROL PLANT. THE RECOVERED ENERGY WILL SUPPLY MOST OF THE STEAM AND ELECTRICITY NEEDS OF THE EXPANDED VICTORIA HOSPITAL AND OTHER HOSPITALS ON THE SITE.

THE PROJECT UNDERWENT A THOROUGH ENVIRONMENTAL REVIEW BEFORE IT RECEIVED THE NECESSARY APPROVALS. A REQUEST FOR CAPITAL ASSISTANCE IS CURRENTLY BEFORE THE ONTARIO CABINET, AND A DECISION SHOULD BE ANNOUNCED SHORTLY.

FOR THE FEDERAL GOVERNMENT'S PART, GRANT PROGRAMS SUCH AS FOREST INDUSTRY RENEWABLE ENERGY PROGRAM OR FIRE, AND THE CLASS 34 TAX INCENTIVE PROGRAM, MUST BE MAINTAINED TO ENSURE COMMERCIALIZATION OF ENERGY FROM WASTE. THAT WAY, THE PRIVATE SECTOR COULD MOBILIZE LARGE POOLS OF PRIVATE CAPITAL.

FOR THE PROVINCE'S PART, WE WILL CONTINUE TO SET THE STAGE BY PROVIDING 50 PER CENT OF THE COST OF DEVELOPMENT AND SOME CAPITAL SUPPORT FOR A LIMITED NUMBER OF PROJECTS. WE WILL DO EVERYTHING IN OUR POWER TO PROVIDE A FAVOURABLE CLIMATE BY HELPING TO REMOVE INSTITUTIONAL BARRIERS.

MUNICIPALITIES MUST ALSO PLAY A PIVOTAL ROLE IN THE DEVELOPMENT OF ENERGY FROM WASTE. FIRST AND FOREMOST, THEY MUST BE WILLING TO PLAN FOR ALTERNATIVE DISPOSAL METHODS. LANDFILL IS NOT THE BE ALL AND END ALL.

THEY MUST BE WILLING TO LOOK BEYOND THE UPFRONT COSTS. THERE IS NO DOUBT THAT A LANDFILL SITE IS CHEAPER TO START THAN AN ENERGY FROM WASTE PLANT. BUT, TAKEN OVER THE LIFE SPAN OF BOTH, ENERGY FROM WASTE PLANTS ARE COST COMPETITIVE, WHEN FACTORS SUCH AS THE EXTENSION OF LANDFILL OR THE COST OF OPENING AND OPERATING NEW SITES ARE TAKEN INTO ACCOUNT.

EQUALLY IMPORTANT IS THE ENCOURAGEMENT AND SUPPORT THAT MUNICIPALITIES CAN EXTEND TO PRIVATE INTERESTS WILLING TO GET INTO THIS FIELD. I MIGHT ADD THAT QUEBEC CITY, CHARLOTTETOWN AND HAMILTON HAVE AGREEMENTS WITH WASTE MANAGEMENT COMPANIES TO OPERATE THEIR ENERGY FROM WASTE FACILITIES.

AND, LAST, BUT NOT LEAST, MUNICIPALITIES MUST BE PREPARED TO ANSWER THE CONCERNS OF ITS RESIDENTS. THIS IS RECENT TECHNOLOGY FOR NORTH AMERICA. NATURALLY, THERE ARE GOING TO BE MANY QUESTIONS.

IN SUMMARY, ONTARIO IS POISED AND READY TO CAPTURE THE OPPORTUNITIES FOR ENERGY ALTERNATIVES IN THE DECADES AHEAD -- OPPORTUNITIES SUCH AS THE RECOVERING OF ENERGY FROM WASTE.

ONTARIO'S PRODUCTIVITY WILL BE ENHANCED. THE CHALLENGE IS TO USE LESS ENERGY AND MATERIALS IN OUR MANUFACTURING PROCESSES. ENERGY FROM WASTE CAN HELP MEET THIS CHALLENGE.

BUT, AS I HAVE TRIED TO SHOW IN MY REMARKS, PUBLIC AND PRIVATE COMMITMENT ARE ABSOLUTELY ESSENTIAL. JUST ABOUT EVERYBODY IS OPERATING UNDER SOME FINANCIAL RESTRAINT. SO ALL PARTIES MUST BE PREPARED TO WORK TOGETHER, TO SHARE THE RISKS AS WELL AS THE REWARDS.

THIS IS STARTING TO HAPPEN IN ONTARIO, AS I POINTED OUT. ENERGY FROM WASTE AND BUSINESS GO HAND IN HAND. IT IS A NEW BUSINESS CHALLENGE AND, FROM IT, IS EMERGING A NEW BREED OF ENERGY COMPANY. ALREADY IN NORTH AMERICA, THERE IS AN ESTIMATED $3-BILLION INVESTED IN ENERGY FROM WASTE PROJECTS.

ENERGY FROM WASTE FACILITIES MAKE A GREAT DEAL OF SENSE. THEY REPRESENT AN ENVIRONMENTAL MANAGEMENT PRACTICE THAT STRESSES RELIANCE ON THE "INCOME" FROM OUR NATURAL RESOURCE BASE, AND NOT A FURTHER "WITHDRAWAL" FROM THE PLANET'S CAPITAL.

THEY REPRESENT A POLITICAL AND SOCIAL WILL TO TACKLE OUR GROWING WASTE DISPOSAL PROBLEMS NOW.

THEY REPRESENT AN OPPORTUNITY FOR A BETTER, MORE SUSTAINABLE FUTURE FOR ALL OF US.

THANK YOU.

WASTE TO ENERGY SYSTEMS

by
G.C. Chisamore, Manager, Municipal Waste Unit, Biomass/Energy from Waste Section, Ontario Ministry of Energy, Toronto

INTRODUCTION

The waste which we put out for pick up this morning can provide energy for offices, hospitals, industry or homes to-morrow. Although this has been happening in Europe for many years, it has not been adopted in Ontario.

This morning, I want to give an overview of the technology that is available to convert the energy value in MSW to a useful form and to give some personal comments on their application.

TECHNOLOGIES AVAILABLE

The technology systems which are available or under development include:

- mass burning incinerators
- modular incinerators
- semi-suspension burning systems
- refuse derived fuel systems
- gasification/pyrolysis systems

Some comments and key features of each system are provided as follows:

MASS BURNING INCINERATORS

These systems are characterized by the direct combustion of waste without size reduction or waste processing. Only the very bulky waste is reduced in size by a shear in order to allow the waste to enter the furnace.

The units are characterized by a moving grate system. There are a number of suppliers with unique designs and claims for special features for that design. These grate systems are typically supplied from Europe. For purposes of energy recovery, the units can be either water wall or refractory lined with a waste heat boiler.

On the sloping grate which is typical of most of these systems, a number of reactions occur,

- drying
- distillation
- combustion
- burn-out

FEATURES

- well established tecnnology
- over 40 years of operating history
- rugged and reliable
- can produce high pressure steam for power generation
- high building profile
- nign capital cost per daily ton
- common size range of 100 T/D to 750 T/D per unit.
- use of pit and crane for waste handling

APPLICATION

The mass burning systems can be considered for almost all situations, however, from a practical sense, economics rather than technology will likely show that these systems will not be competitive below 300 tons per day capacity. The energy product can be steam, hot water or electricity.

MODULAR INCINERATORS

The modular incinerators were developed in USA in unit sizes of less than 10 T/D. Typical applications for MSW are in unit sizes of 25 - 75 T/D with some systems having a capacity in excess of 100 T/D per unit.

These systems also burn waste witnout size reduction and usually are designed to handle residential waste or commercial and industrial waste. They are typified by a two chamber design with final combustion taking place in the secondary chamber. The design usually incorporates the capacity to use auxiliary fuel in the secondary chamber to maintain combustion temperature at a minimum level.

FEATURES

- two chamber design
- lower levels of excess air reguired
- small unit sizes
- about 10 years of operating history on MSW
- lower energy recovery efficiency than mass burning (55-60 vs 65-70)
- lower capital cost per daily ton
- commonly use a flat floor and a front end loader for waste handling.

APPLICATION

These systems were developed for waste capacities nominally in the range of 100 T/D. Plant capacities in the 200-300 T/D range are now operating but the practical upper limit has yet to be reacned. The energy product is usually steam of relatively low pressure (200 psi) nowever systems capable of producing steam at up to 600 psi are operating. At this pressure, co-generation of electric power can be considered.

SEMI-SUSPENSION BURNING SYSTEMS

The combustion system was adapted from waste wood burning boilers and requires processing of the waste before it can be burned. The unit operations are as follows:

- size reduction to 6" or less
- removal of some of the non-combustible material - usually limited to ferrous metals
- burning in a dedicated boiler designed for the fuel
- burning takes place partly in suspension with final burn-out on a grate

FEATURES

- limited operating experience
- not suited for plant sizes below about 400 T/D (economies of scale)
- lower excess air requirements than mass burning
- higher energy recovery efficiency
- lower capital cost per daily ton than for mass burning
- adaptable for material recovery

APPLICATION

The practical limitation for this technology would be for projects with a capacity greater than 400 T/D. This technology can be adapted to incorporate material recovery as the technology and markets develop. The energy product can be steam, hot water or electricity.

REFUSE DERIVED FUEL SYSTEMS

Interest in the RDF systems was greatest in the '70's and although these systems were being considered throughout the world, they were pursued more vigorously in North America. The unit processes include:

- primary shredding
- screening or air classification to remove the non-combustibles
- secondary shredding
- classification
- storage

For densified RDF, additional processing such as drying, chemical treatment and pelletizing or briqueting takes place.

FEATURES

- produces a fuel which can be:
  - transported and stored
  - burned in existing boilers or cement kilns
  - blended with other fuels
- limited successful operating history
- lower capital cost per daily ton
- higher operating costs
- problems with waste processing such as explosions in the primary shredder
- densified RDF systems have high maintenance costs
- most readily adaptable for material recovery.

APPLICATION

The refuse derived fuel systems provide greater flexibility for material recovery, however, in Ontario, the market sector for solid fuels is quite limited. Industries such as the cement industry are able to use low quality fuels but at the moment, it is economics not technology which limits the use of RDF. The energy product is a solid fuel which could displace oil, natural gas or coal.

PYROLYSIS/GASIFICATION SYSTEMS

A great deal of work has been done to develop gasification and pyrolysis systems because of the advantages which these systems can offer. Consider for example the expenditures by Monsanto on its Langard system - rotary kiln gasifier; Union Carbide and Andco Torrox on slagging gasifiers and others such as Occidental.

Interest in gasification continues although work appears to be concentrated on more uniform waste materials such as wood residues. Research with MSW is continuing at a number of locations but more work is required before pilot scale facilities cna be considered. The Ministry has been approached for funding assistance to develop a gasifier which has evolved from work done at Redwood City California but no funding commitment has been made.

On the international level, a system is reported to be operating in Italy producing an oil and a solid char. To date we have not been able to substantiate the claims made for this Rossi process. Researchers at Manchester University Institute of Science and Technology are working on a process to convert garbage to oil but, to my knowledge, the development is still at the laboratory scale and is not ready for pilot scale testing.

These developing systems continue to be of interest, however they are not critical to the success of the energy from waste industry.

POLLUTION CONTROL

Incineration of municipal refuse, like any other combustion process, results in a discharge of flue gas, vapours, liquids and particulate to the atmosphere. Until recently, an efficient electrostatic precipitator for control of particulate and a tall stack for the dispersion of gaseous pollutants has been adequate to meet air pollution requirements.

The increasing amounts of chlorinated plastics in the waste steam has raised concern over the environmental effects of the acid gases produced in the incineration process. There is a trend towards the installation of flue gas scrabbing systems to control the emission of acid gases.

Two basic scrubber systems have been used - a wet scrubber system using a washing fluid containing chemical reaction compounds in solution and the semi-dry scrubber where the chemical reaction compounds are sprayed into the flue gas in the form of a slurry.

Flakt has developed a new system for flue gas cleaning with dry absorption of the acid gas components. The first system was installed at the Sysav plant in Malmo Sweden. The process layout of the Sysav plant is shown in Figure 1. Test results carried out with that system in 1983 are shown in Table 1.

In a review of air pollution control technology completed for the ministry, the author concluded that the reduction of gaseous pollutants will become a requirement in the near future. In his opinion, dry absorption systems followed by an electrostatic precipitator or a fabric filter are best suited for controlling particulate and gaseous emissions from the combustion of municipal solid waste and could be considered best available control technology.

In my opinion, the experience at the public hearing for the Victoria Hospital Energy from Waste Project supports the claim that the best available control technology must be utilized.

THE TECHNOLOGY PUZZLE

In addition to the complex choice of technology, there are a number of other factors which add to the pieces in the puzzle. These include:

- plant size
- utilization factor
- co-generation

- impact of changes in waste composition
- impact of source separation or recycling
- processing for material recovery

There is no easy answer to these questions but a successful project doesn't just happen - it requires proper planning. There are some general rules which should be followed:

1) Be sure of the waste supply.
2) Be sure of your market.
3) Consider all appropriate technologies.
4) Recognize and manage project risks.
5) Protect the environment.

Summary

In conclusion, there is a wide range of proven technology systems which can be utilized to recover energy from waste. As well, there is a growing Canadian industry which is prepared to supply turn-key or full service systems to industry or municipalities. It is no longer appropriate to ignore the opportunities for extracting energy from waste because "garbage is not our business". We need to look at the other side of the coin which says that those materials which we have been discarding are not waste but a resource.

We must utilize this resource to conserve our diminishing fuel supplies and at the same time recover materials for recycling. Energy from waste is not a panacea but it is an option that provides many opportunities. Our challenge is to use our engineering and business skills to develop those opportunities to the benefit of society.

References

1. Operational Studies at the Sysav Energy from Waste Plant Malmo, Sweden June 1983
   Translation by Flakt Canada

2. Study for the Ministry of Energy
   Overview of Air Pollution Control Technology for Energy from Municipal Solid Waste Plants
   Dr. A. Taha March 1984

3. Engineering Review of Air Emission Control for SWARU - March 1984

   Study for Ministry of the Environment by MacLaren Engineers

Acknowledgements

1. Flakt Canada - slides of the dry scrubbing system and performance at Sysav, Malmo.

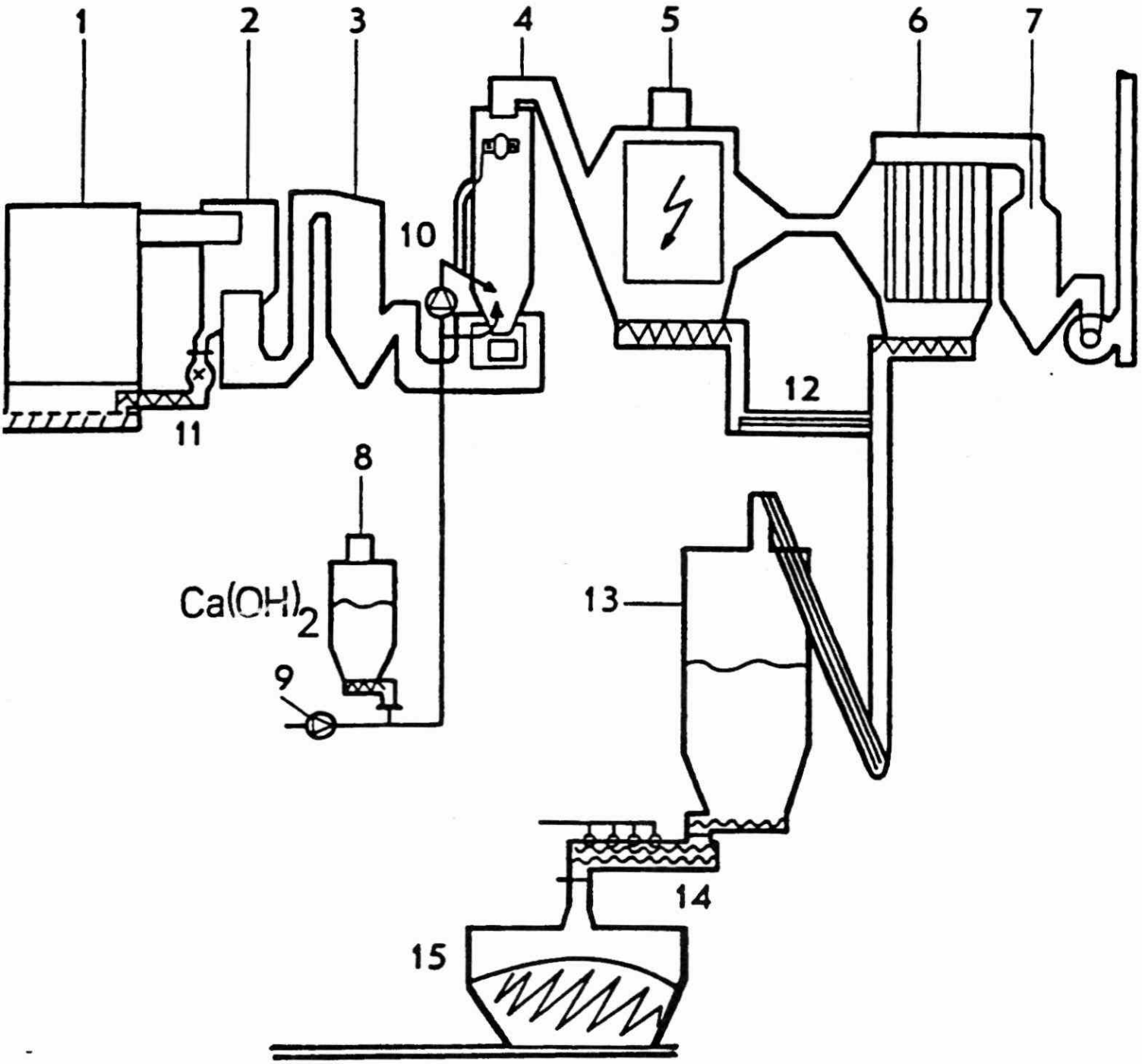
2. Tricil Limited - slides of EFW plants at Charlottetown and Akron.

FIGURE 1

Flakt Canada Ltd

DRY ABSORPTION SYSTEM

MUNICIPAL WASTE INCINERATOR SYSAV,MALMO



1. Furnace and Boiler
2. Precollector
3. Waste Heat Boiler I
4. Reactor
5. Electrostatic Precipitator
6. Fabric Filter
7. Waste Heat Boiler II
8. Lime Silo
9. Lime Feeding
10. Lime Recirculation
11. Coarse Dust Conveying
12. Fine Dust Conveying
13. Dust Silo
14. Dust Humidifier
15. Dust Bin

Flakt Canada Ltd

FLAKT DRY ABSORPTION SYSTEM AT SYSAV
WASTE INCINERATOR MALMÖ

REF. DRAV DRIFTSTUDIE - JUNE 1983
FLAKT MEASUREMENTS JULY 1983

INCINERATED WASTE 10.5 TON/H

HYDRATED LIME 210 KG/H

O_2 7.5 ± 1.4 %

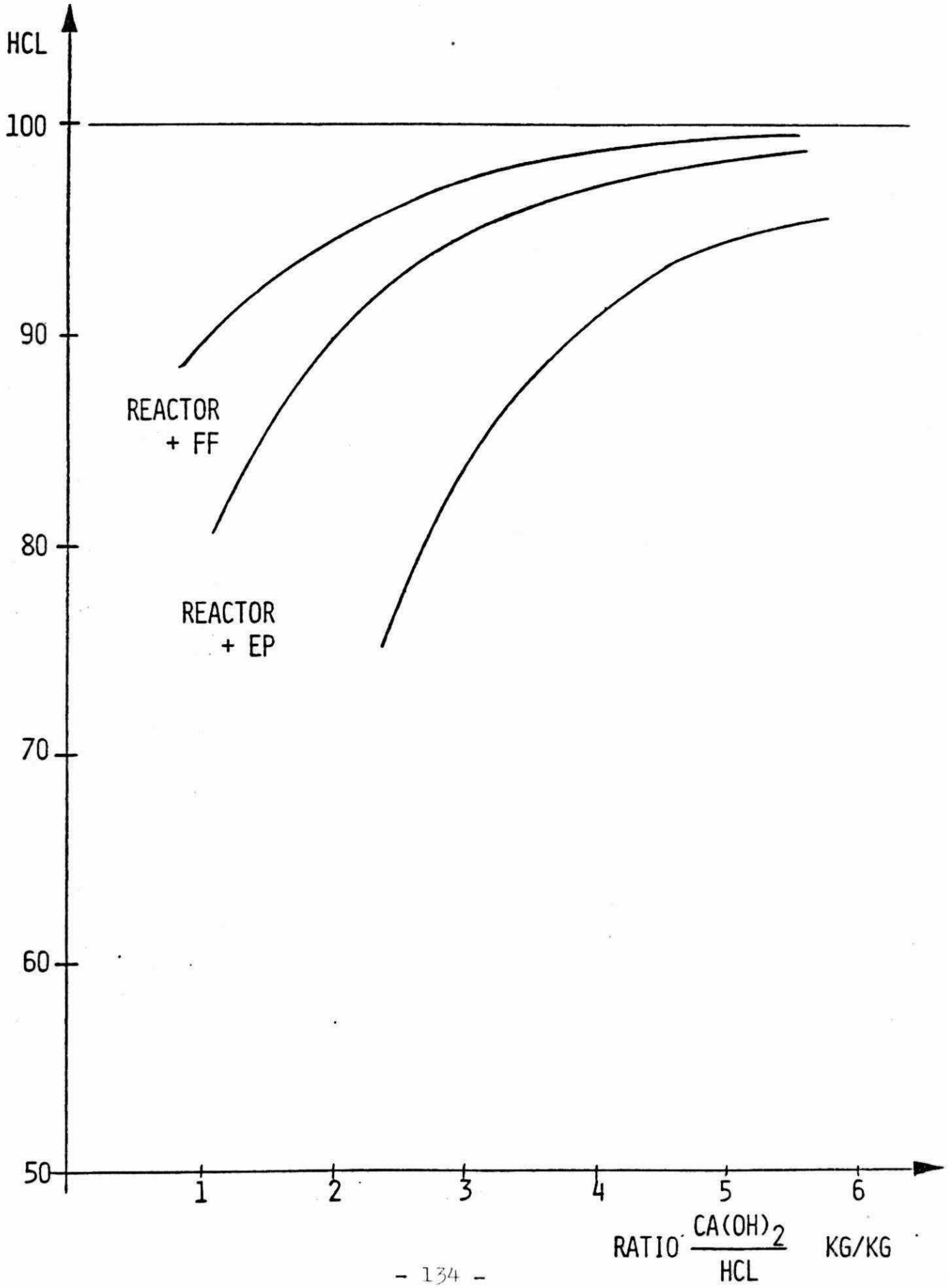
CO 153 ± 87 MG/M^3 NORM

ELEMENT	TOTAL CONCENTRATION		COLLECTION
	INLET	OUTLET	
DUST	4000	5	99.88
ZN	49.1	0.076	99.85
PB	11.9	0.012	99.9
CD	0.57	0.0001	99.98
HG	0.26	0.018	93.1
HCL	1000	100	90
SO_2	250	100	60
HF	10	<0.1	>99
ΣPAH		0.003	
PCDD		$<0.25 \cdot 10^{-6}$	
PCDF		$<0.25 \cdot 10^{-6}$	

ALL CONCENTRATIONS IN MG/M^3 NORM DRY GAS AT 10 % CO_2.

Fläkt Industri AB

FLÄKT DAS: HCL-ABSORPTION



THE ECONOMICS OF ENERGY FROM MUNICIPAL SOLID WASTE PROJECTS IN ONTARIO LESSONS FROM THE LONDON VICTORIA HOSPITAL ENERGY FROM WASTE PROJECT

by
Terry Burrell, Principal, Victor & Burrell Research and Consulting, Toronto, Ontario

I would like to thank the organizers of the Conference for the opportunity of speaking to you today on the economics of energy from waste projects in Ontario.

Economics appears to be the primary peoccupation of proponents and prospective proponents of energy from waste (EFW) projects in Ontario. The major questions about EFW technological performance appear to be resolved, so the key issue is whether or not EFW can make money.

1. Some General Conclusions Concerning EFW Economics in Ontario

Does EFW make economic sense? Part of the problem in answering this question for Ontario is that it is very difficult to generalize from the feasibility studies done to date. While a wide variety of projects have been analyzed in Ontario, the lack of a consistently applied, comprehensive approach to economic evaluation makes it extremely difficult to come to firm conclusions about the economics of EFW in Ontario.

With this caveat clearly in mind, I would like to indicate what the evidence seems to indicate. EFW can make economic sense, but only under

certain conditions. I have looked at projects with nominal internal rates of return ranging from -30% to +30% (real rates of return in the -20% to +20% range). The ones that are economically attractive appear to have two, or more, of the following characteristics:

1. Energy utilization and avoided cost are comparatively high.

2. The avoided costs of municipal solid waste disposal and/or collection are comparatively higher.

3. The proponent captures most of the economic benefits generated by the project.

4. The rate of return on investment demanded by the proponent is not particularly high. The most attractive projects I have seen yield real rates of return on total capital in the 10 to 15% range. This return is normally quite acceptable to public sector proponents, but may not be adequate for some private sector investors.

5. The project's economic analysis makes assumptions about energy price increases that would be considered optimistic by the current conventional wisdom.

What about the current economic outlook and present perception that energy prices are not likely to increase at nearly the same rate that we thought they would increase two or three years ago? It is obvious that the decrease in projected energy prices leads to a decrease in return to these projects. The key issue is whether the decline is sufficiently steep to render the projects economically unappetizing. It is difficult

to generalize. Our experience with the Victoria Hospital project may be indicative, however. When we recently ran a scenario of future energy prices which projected a real decline over the next two years, on average 5%, with 0% real increase after that to the end of the project's economic lifetime, the outcome remained significantly positive in net present value terms (we used a discount rate of 5% real). Naturally the rate of return decreased, and the economic attractiveness to the proponent went down, but the project was not rendered an economic non-starter as a result.

2. Economic Analysis and EFW Projects - Lessons From the London Victoria Hospital Project

With these overall considerations as an introduction I would like to touch on two issues. The first, is the kind of economic analysis that I have found useful for EFW projects. The second is EFW project characteristics which can help their economic performance. I am going to deal with these principally by talking about the EFW project which is currently proposed for Victoria Hospital in London, Ontario. This is the project which is the furthest along the road to approval in Ontario and it is the project with which I am most familiar. My firm did the economic analysis for the project.

I want to linger for a moment on the first issue -- the kind of economic analysis which I have found most useful for EFW projects. When I talk about being useful, I do so from a number of angles. The first is from the point of view of assessing how EFW projects actually perform economically, how they actually stack up. The second concerns utility

from the point of view of assisting in the negotiations amongst the principal parties involved in the project -- such as the energy user, the supplier of solid waste, and the builder and operator of the plant. The final perspective entails utility in terms of what seems to help in dealing with governmental requirements -- during grant negotiations and for regulatory approval. If you are involved with EFW in Ontario, you will be dealing with the federal and provincial governments for grants and routine approvals, and you may very well become involved in the Environmental Assessment process.

I would like to give you some details on the Victoria Hospital project before going any further. The proposed project produces steam and electricity. The electricity is co-generated and all of it is used by the Hospital. The primary fuel is municipal solid waste; the supplementary fuel is natural gas. The plant will also incinerate municipal sewage sludge. Plant capacity is 300 tons a day for municipal solid waste (as currently proposed, 3 incinerators at 100 tons per day each). This is equivalent to 88,000 tons per year at 85% capacity. The sewage sludge component has a capacity of 220 tons per day (20% dried solids).

Victoria Hospital is engaged in a large facility expansion at its Westminster Campus. The EFW project arose out of this expansion. The mechanical engineers for the Hospital, The ECE Group, who have expertise in the EFW area, suggested the Hospital consider an EFW project for its steam plant. The Hospital saw this as a potential opportunity to save on its operating costs. The City of London viewed it as a potential cost

saver, a way to deal with its solid waste problems and a potential solution to its sludge management concerns.

Figure 1 will give you some idea of what stages a project like this goes through on the path to approval. The project is currently involved in preparations for tendering -- stage 6. I will now go through each of the points in Figure 1, briefly describing the background and status of each.

The pre-feasibility analysis was undertaken by The ECE Group as part of its assessment of the expansion of the Hospital's steam plant. This analysis found the project to be technically feasible and economically attractive. This work resulted in the decision to proceed to a full-blown feasibility analysis.

The feasibility analysis was funded under a cost-sharing agreement with the Ministry of Energy; and included the Ministry of Health, City of London as well as the Hospital. My firm became involved at this point, as did MacLaren Engineers, who provided the engineering expertise for the sludge component of the plant. The detailed feasibility analysis concluded that the project was technically feasible, economically viable and financially feasible.

At this point, in order to ensure that the major details between the key project actors were in place, an agreement was negotiated between Victoria Hospital and the City of London. This agreement was needed to tie down a number of details -- principally, the supply of solid waste, the tipping fees for solid waste and sludge, and the capital contribution

from the City.

The fourth stage, that of obtaining government approvals, was begun in the winter of 1981. A number of routine approvals were required including those under the Environmental Protection Act, Municipal Board approvals, etc. In addition, in order to deal with the environmental concerns surrounding the project, the Hospital voluntarily designated itself under the Environmental Assessment Act. The decision was made to deal with a number of these regulatory matters together under the Consolidated Hearings Act (1981) before the Joint Board (Environmental Assessment Board and Ontario Municipal Board).

The documentation for the Environmental Assessment was prepared in July 1982. Review and document supplementation took place after this, with hearings beginning in early 1983. The hearings finished in late spring of 1983. Final approval for the project was given in the fall of that year.

With major approvals in hand, the project proponents engaged in grant negotiations with the federal and provincial governments. These were recently completed. With the tentative grant levels fixed, the proponent was prepared to move to the tendering process. Tendering documents are currently being prepared.

I would now like to go back to stage 2, the point at which the feasibility analysis was being done, since I want to describe to you the approach that we took in preparing the economic analysis for it.

Figure 2 outlines the options considered and the general approach taken by the economic assessment. For the feasibility analysis, we considered three major options -- no EFW project (a conventional energy plant), an EFW project including the incineration of sewage sludge and an EFW project with no sewage sludge. For both of the EFW project options we looked at variations of plant size and also examined the effect of including electrical co-generation.

The feature of the overall approach that I would like to stress is that we broke the analysis into two major components -- a least cost overview and an analysis from the proponent's perspective. I will discuss this distinction below.

For each of the two components we based our analysis on a "base case" which we defined with relatively conservative assumptions. That is, we selected assumptions about technology, energy performance, costs, revenue, etc. which would tend to err on the side of underestimating the attractiveness of the project.

Least Cost Analysis:

The purpose of the least cost analysis is to identify the true cost differences between the EFW option or options and the alternative that would be pursued if an EFW project were not undertaken. Thus the analysis is performed independently of grants, distributional considerations, and financing details. In other words, cost implications of each alternative are assessed regardless of who incurs them -- no

grants, no tipping fee assumptions (we ignored the specific deals that are made including any break on energy prices) and no financing assumptions (no debt/equity split, lease vs loan, etc.)

I should point out that this analysis formed the basis for all of the subsequent economic work we did for the project. All of the EFW feasibility studies that I reviewed before doing this project and most of the ones I have looked at since ignore this "least cost" perspective. They look only at the project from the proponent's perspective, a perspective which inevitably involves distributional considerations -- grant, financing details, etc. This severely restricts the analysis and can create serious misperceptions about the project's economic performance.

The net present value of the EFW options was compared with the no EFW option. The base case was assessed and a sensitivity analysis was performed for a number of key variables: discount rate, energy prices, general inflation rate, and capital costs of the energy from waste plants.

As indicated in the second part of Figure 3, each option's costs included three major components -- Victoria Hospital's energy costs, the City of London's solid waste costs and the City of London's sewage sludge costs. The costs were calculated as the expenditures that would be made in the year in which they are actually made over the project's lifetime, beginning with the construction period and ending with the last year in the economically useful lifetime of the plant (a 20 year operating period

for the EFW plant).

This highlights the importance of being comprehensive, and of estimating the actual costs that are likely to be incurred under each option. This latter point means that it is not possible to use average solid waste collection disposal cost for example, as a surrogate for what is likely to happen to solid waste disposal costs with the EFW plant implementation.

For Victoria Hospital energy costs, all of the cost associated with building and operating the energy plant were included.

Each option's solid waste transportation costs were calculated by modelling the transportation routes. Landfill operating costs were calculated by relating expenditures to volume hauled. In the case of the conventional plant, the transportation and landfill operating costs were calculated on the basis of handling the total projected quantities of solid waste generated in London. For the EFW options, the transportation routes and landfill operating costs were calculated on the basis of the projected quantities of solid waste being routed to the Hospital EFW plant rather than to landfill.

The year in which new landfill capacity would be required was calculated for each of the options. The cost of the landfill acquisition was projected including the full range of legal and related expenses associated with landfill approval, as well as land acquisition costs. I should point out that the assumptions made were quite conservative -- we

assumed that London could acquire the same landfill at the same as it cost to acquire it during the middle 1970's.

A similar approach was taken to calculating the costs of sewage sludge management, including the transport and incineration of sludge. Both the capital and operating costs of incinerating the sludge were taken into account.

The results of the base case analysis showed significant savings at a discount rate of 5% real. The sensitivity analysis revealed a positive net present value over a wide range of assumptions. (See the first part of Figure 3 for a list of sensitivity analysis variables).

The results of the analysis which were prepared for the project at a later stage (during the Environmental Assessment Hearings) are presented in Figure 4. The EFW option with sludge is compared with the no EFW option. This summarizes the cost for each option in total -- energy, solid waste and sludge costs are all rolled together. You will note that the energy from waste project has higher costs in the first two years (the construction period for the project), but lower operating costs throughout the rest of the plant's lifetime. You will also note the relatively small difference between operating costs in the early period. In part this reflects the assumption of relatively low operating rates for the plant in the first two years after plant start-up. The effects of landfill acquisition are shown by the two arrows.

I would like to return to the analysis of the project from the

proponent's perspective. It takes into account the kind of factors listed in Figure 5. Thus the distributional effects of the proposed project, including the tipping fee and energy prices negotiated, the capital contributions made by other parties, the grants obtained from government and interest rate on short and long term finance are all considered.

Figure 6 shows the projected savings to Victoria Hospital under assumptions that were made at a relatively early point in the project analysis. As you can see, the project savings are considerable. However, the initial period of the project's cash flow is taken up with covering a shortfall. This explains some of the financing problems encountered by these projects -- they are capital intensive, generally requiring a relatively high debt load.

The analysis of the project from Victoria Hospital's perspective revealed significant economic savings for the Hospital. On this basis the Hospital decided to proceed with the project.

I would like now to turn to some of the advantages of undertaking the economic analysis in the two parts described above. As Figure 7 indicates, the two part approach gives both an evaluation of the performance and attractiveness of the project to the proponent and provides a firm basis for testing project restructuring. The least cost analysis provides a useful input into negotiations among parties, since it makes it clear to those involved what the total savings of the project are. It also assists in dealing with the government -- government is

interested both in the overall project "cost benefit" (as embodied in the Environmental Assessment process) and in the specific economic advantages and disadvantages to the proponent.

The two part approach proved to be extremely useful for the Environmental Assessment process. The Environmental Assessment Act defines economics to be part of the "environment" considered. Thus, economic evaluation is a necessary part of an environmental assessment. The Act emphasizes the importance of considering alternatives to the proposed project; consequently, the approach of identifying the major alternatives and analysing them separately is quite useful.

When we undertook the Environmental Assessment for the Victoria Hospital analysis we were able to draw heavily on the work that we had done on the feasibility analysis. We extended the assessment to include both a number of additional options (eg., moving the plant some distance from the Hospital) and to include the regional economic impacts with the project -- effects on provincial gross domestic product and impacts on employment.

The evidence that an analysis such as the one undertaken by us for Victoria Hospital can be useful in the Environmental Assessment process was indicated by the fact that the Joint Board showed an interest in both parts of the analysis. The Board wanted to see both the least cost analysis -- the indication of the "true worth" in economic terms of the project -- and the attractiveness of the project to the proponent.

In conclusion, I would like to discuss some of the distinguishing characteristics of the Victoria Hospital project. As Figure 8 indicates, the Hospital is the proponent of the project. This has a number of advantages. First of all, because the Hospital is in the public sector, its "hurdle rate of return" -- the economic return it expects -- is not high, at least in comparison with some private sector proponents. Secondly, because the Hospital is the energy user, it captures the full value of the energy savings. It is not forced to use energy pricing as a marketing incentive. The energy savings are high, in part because the Hospital has such an attractive energy load -- relatively flat in comparison with other EFW projects (7 day a week, 52 weeks a year). The market risk of the project is minimal, since it is virtually certain that the Hospital will continue to exist and demand the energy provided by the plant.

Thus, the projected energy savings captured by the project proponent are quite high. On the other hand, the City of London's solid waste disposal costs tend to be on the low side. The City has ample landfill capacity for the next 15 years or so. However, the location of the EFW plant will help with transportation costs and the decrease in quantities flowing to the landfill will cut down on operating costs. It is these latter two components which comprise the savings upon which the (comparatively low) tipping fee is based.

The two major players were able to negotiate a satisfactory agreement. All of the important considerations involving the supplier of solid waste and the proponent were dealt with. An agreement of this kind is

essential.

It is difficult to overemphasize the importance of financing. Because these plants are capital intensive, financing is critical. Financing considerations should enter in right at the beginning of project assessment. At present it appears certain that the Victoria Hospital project will be financed using a lease arrangement. This will permit the passing through of Class 34 tax deduction advantages to the private sector lessors, giving the proponent a lower rate on long term debt than would be otherwise obtainable. Other features including a cash flow deficiency guarantee have helped distribute project risks.

The project has shown itself to be relatively resilient to changing conditions. The altering perspectives on energy prices, as I mentioned previously, have decreased the returns expected from the project, but not to the point where the project is no longer attractive. However, I should emphasize that the project cannot take much more of this kind of decline in expected revenue without a serious deterioration in economic performance.

FIGURE 1

PRINCIPAL STAGES IN PROJECT EVALUATION AND APPROVAL

1. Pre-Feasibility Analysis

2. Feasibility Analysis

3. Agreement Between Victoria Hospital and City of London

4. Government Approvals
   - Environmental Assessment and Related

5. Grant Negotiations

6. Tendering Process

7. Final Project Approval

FIGURE 2

ECONOMIC ANALYSIS PERFORMED: FEASIBILITY STUDY

OPTIONS CONSIDERED

- No EFW Project
- EFW Project - Sewage Sludge
  - -- Variations
- EFW Project - No Sewage Sludge
  - -- Variations

GENERAL APPROACH TAKEN

- Two Major Components
  - -- "Least Cost" Overview
  - -- Proponent's Perspective
- Base Case - Conservation Assumptions
- Sensitivity Analysis

FIGURE 3

LEAST COST OVERVIEW

Purpose: Assess Economic Characteristics of Project Independently of:

- -- Grants
- -- Distributional Considerations
- -- Financing Details

. Assess Cost Implications of Each Alternative Regardless of Who Incurs Them:

- -- No Grants
- -- No Tipping Fee Assumptions
- -- No Financing Assumptions

. Identify Net Present Value and Internal Rate of Return of EFW Options Compared With No EFW Option

. Sensitivity Analysis On:

- -- Discount Rate
- -- Energy Prices
- -- General Inflation
- -- Capital Costs

FIGURE 3

LEAST COST OVERVIEW - CONT'D

THREE MAJOR COMPONENTS:

Victoria Hospital Energy Costs

- Capital
- Operating

City of London: Solid Waste

- Transporation
- Landfill Operating
- Landfill Acquisition

City of London: Sewage Sludge

- Transportation
- Incineration - Capital
- Incineration - Operating

Results of Analysis

- Base Case
- Sensitivity Analysis

FIGURE 4

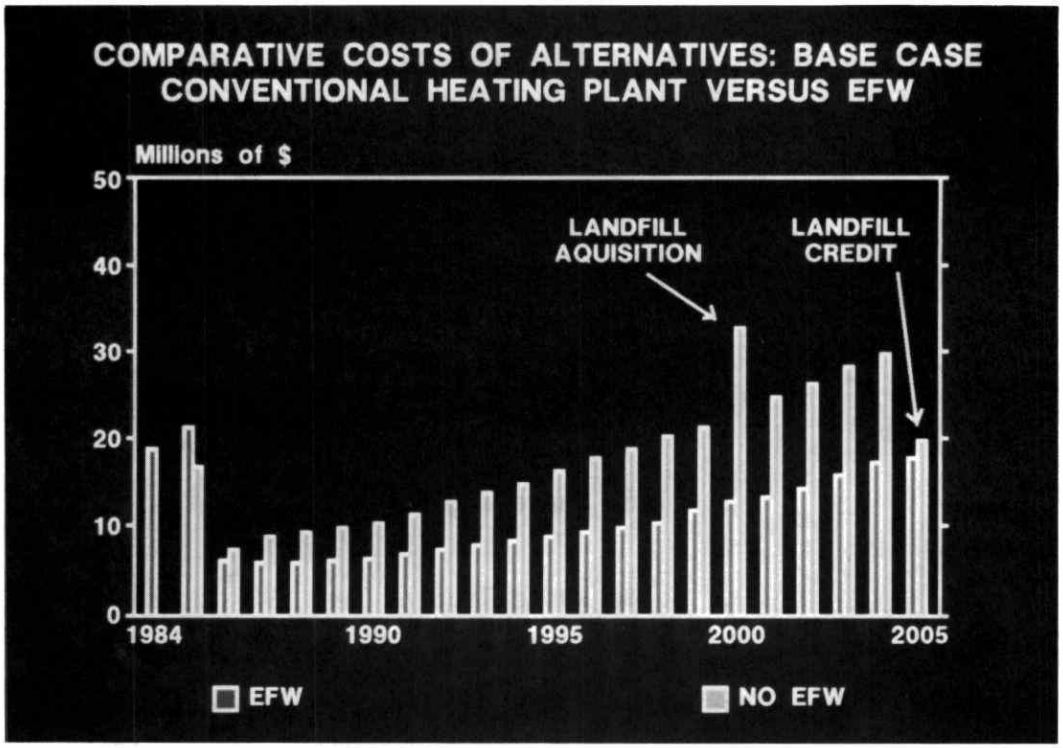

COMPARATIVE COSTS OF ALTERNATIVES: BASE CASE
CONVENTIONAL HEATING PLANT VERSUS EFW
Millions of $
50
40
30
20
10
0
LANDFILL AQUISITION
LANDFILL CREDIT
1984
1990
1995
2000
2005
EFW
NO EFW

FIGURE 5

ECONOMIC ANALYSIS - PROPONENT'S PERSPECTIVE

Purpose: Assess Economics of Project From Victoria Hospital's Point of View

FACTORS CONSIDERED:

- Plant In-Service Cost
- Plant Operating Cost
- Solid Waste Tipping Fee
- Sludge Tipping Fee
- Capital Contributions
- Government Grants
- Other Financing Details

FIGURE 6

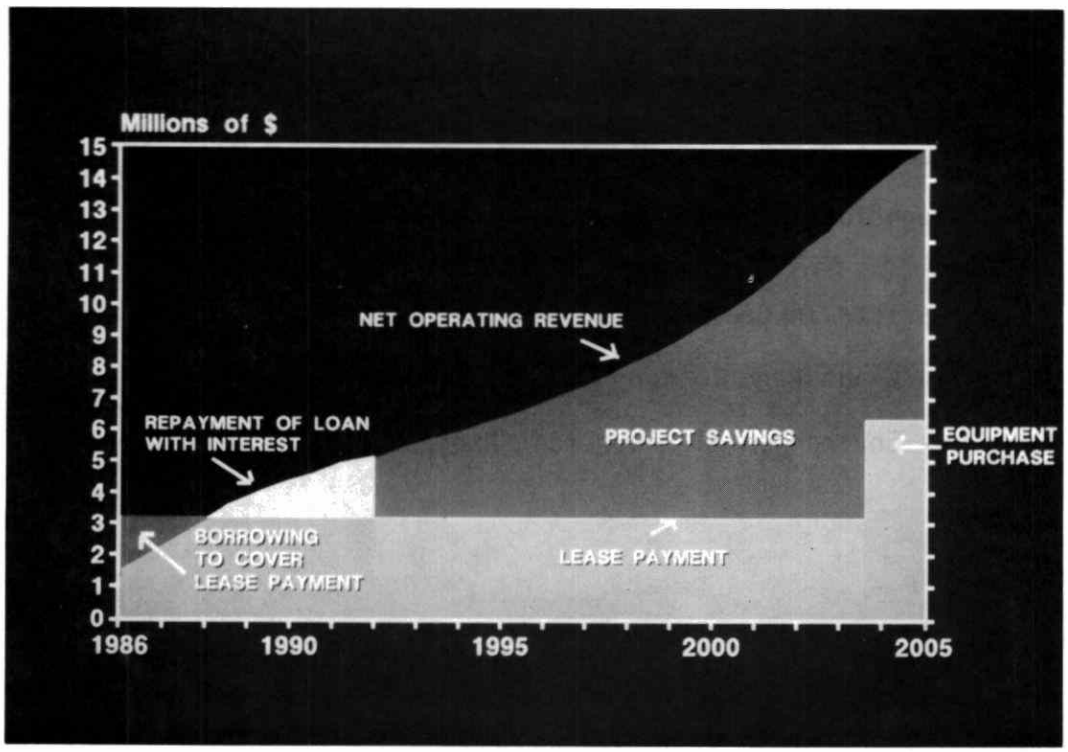

Millions of $
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1986
1990
1995
2000
2005
NET OPERATING REVENUE
REPAYMENT OF LOAN WITH INTEREST
PROJECT SAVINGS
EQUIPMENT PURCHASE
BORROWING TO COVER LEASE PAYMENT
LEASE PAYMENT

FIGURE 7

ADVANTAGES OF TWO PART APPROACH

- Shows Both Overall Performance and Attractiveness to Proponent
- Provides Firm Basis for Testing Sensitivity of Project Restructuring
- "Least Cost" Analysis Provides Useful Input into Negotiations Among Parties
- Assists in Dealing with Government
  -- Grant Negotiations
  -- Environmental Assessment Process

ENVIRONMENTAL ASSESSMENT PROCESS

- Economics Part of "Environment" Defined in the Act
- Act Emphasizes Considering Alternatives
- Feasibility Analysis of Victoria Analysis Extended to Include Regional Economic Impacts
- EA Panel Showed Interest in Both Parts of the Analysis

FIGURE 8

SOME DISTINGUISHING CHARACTERISTICS

OF VICTORIA HOSPITAL EFW PROJECT

- Hospital is Proponent
  - -- Public Sector
  - -- Full Value of Energy Savings Captured
- City of London's Solid Waste and Sludge Incineration Costs
- Nature of Agreement Between City and Hospital
- Lease Financing
- Sensitivity to Changing Conditions
- Implications for Other EFW Projects?

HAZARDOUS CONTAMINANTS FROM INCINERATION

by
Dr. D. Balsillie, Director, Air Resources Branch, Ontario Ministry of the Environment, Toronto

ACKNOWLEDGEMENT:

A large number of organizations and individuals have been involved in the projects described in this paper. The efforts of these people must be acknowledged as I summarize this work.

A. Air Resources Branch - Ministry of the Environment
   - Gregg VanVolkenburgh
   - Bruce Martin
   - Peter Kupa
   - Lyn Barrow and staff
   - Vlado Ozvacic and staff

B. Laboratory Services Branch - Ministry of the Environment
   - Helle Tosine
   - Laboratory Scientists and Technicians

C. Waste Management Branch - Ministry of the Environment
   - Ron Gotts
   - Neil Ahlberg

D. West Central Region - Ministry of the Environment
   - Grant Mills/Boris Boyko
   - George Hicks

E. Ministry of Labour
   - Doug Harding

F. Ministry of Energy
   - Roger Higgin
   - Carman Chisamore

G. Ontario Research Foundation
   Envirocon Eastern Limited
   MacLaren Engineers Inc.

H. Regional Municipality of Hamilton-Wentworth
   Metropolitan Toronto Public Works Department
   Tricil Ltd.

This list only partially represents the total effort behind the generation of the data gathered during this project.

INTRODUCTION

The Ontario Ministry of the Environment realized a few years ago that there was a need to develop policies for the proper and efficient handling of wastes. Incineration was considered to be an important aspect of this policy. The recovery of energy from this process was a potential bonus. The Ministry became aware that a number of Energy-from-Waste (EFW) plants were being considered for this province. As well, there were several incinerators already operational.

At that time, there was an increasing concern that hazardous contaminant emissions were a by-product of the incineration process. "Dioxins" became a household word. The Ministry knew that first-hand information on the present situation would be required for evaluation of incinerator performance and for use at upcoming environmental assessments for proposed incinerators. As well, it was realized that an ambient air guideline for dioxins and furans would be needed.

INCINERATOR TESTING PROGRAM

An emissions testing program was developed in 1982, to conduct stack sampling tests at 4 Ontario incinerators. These included:

1. Sewage Sludge Incinerator - Ashbridges Bay - Toronto
2. Municipal Refuse Incinerator - Commissioner Street - Toronto
3. Solid Waste Reduction Unit (SWARU) - Hamilton
4. Industrial Incinerator - (Yet to be tested)

The following samples were collected for chemical analysis:

1. Representative Fuel (sludge or garbage)
2. Bottom Ash
3. Precipitator Ash
4. Flue Particulates and Gases

The samples were analysed for the following parameters:

1. Dioxins and Furans
2. Polychlorinated Biphenyls (PCB's)
3. Chlorophenols
4. Chlorobenzenes

In order to carry out this program, the Ministry had to develop methodologies and protocols for the sampling and analysis program. Due to the complex nature of the task and the lack of standard chemical compounds, Dr. Rappe of the Swedish University of Umea was contracted as an expert consultant and analyst for some of the emission samples.

DEVELOPMENT OF A PROVISIONAL GUIDELINE

In conjunction with the testing program, an effort to determine an acceptable ambient air concentration for dioxins

and furans was initiated. By December 1982, Dr. Doug Harding, a toxicologist with the Ontario Ministry of Labour, produced a background document for the development of an ambient air guideline. His recommendation was based on toxicity tests with animals. A safety factor was applied to the "no observable effect" level. All dioxins with four or more chlorine substitutions were considered to be equally toxic to the 2,3,7,8-tetrachloro dibenzo-dioxin (the most toxic isomer). Furans were considered to be 50 times less toxic.

The Provisional Guideline for dioxins (and furans) therefore is 30 pg/m^3 annual average (total dioxins plus furans/50). This translates into a point-of-impingement guideline of 450 pg/m^3 half-hour average.

In August 1982, as part of this Ministry's commitment to tackling the hazardous contaminant problem, the Hazardous Contaminants and Standards Branch was formed. During 1983 this Branch undertook a multi-media review of dioxins and furans. They have been supported in this task by a Scientific Advisory Committee of external experts in this field. The members of this Committee are:

1. Dr. E. Spencer (University of Western Ontario)
2. Dr. O. Hutzinger (West Germany)
3. Dr. S. Safe (Texas - A&M)
4. Dr. G. Plaa (Montreal)

TEST RESULTS - 1982

The dioxin and furan test results are shown in the following table. These are results for the analysis of the 24-hour stack samples collected at the Ashbridges Bay, Commissioner Street and SWARU incinerators.

ALL UNITS - UG/DSCM

LOCATION	TEST #1		TEST #2		TEST #3	
	PCDD	PCDF	PCDD	PCDF	PCDD	PCDF
Commissioner Street	.26	.35	1.2	1.3	1.6	1.4
Ashbridges Bay	.48	.89	1.1	0.5	0.6	2.3
SWARU	8.6	16.3	9.7	35.6	5.8	9.1

The dioxin and furan emission rates (translated into point-of-impingement concentrations) were at very acceptable levels for the Ashbridges Bay and Commissioner Street incinerators. However, at SWARU the point-of-impingement concentrations were 10% greater than the provisional guideline. As a result, the Minister of the Environment requested that the garbage throughput at this incinerator should be reduced by 20%, until the operation of SWARU could be reviewed.

SWARU PROGRAM

In order to deal with the SWARU situation, a number of

management and technical committees were established to carry out the program. The study was to take a detailed look at refuse handling, combustion processes and stack emissions.

At the outset there were some maintenance changes related to the grates and the combustion air ports. Viewports were installed and cold draft tests were conducted inside the boilers. In the spring of 1983, another set of combustion and emission tests were carried out. At the outset 64 tests, varying the feed rate and air flows, were considered optimal. However, budget and time constraints reduced this to a matrix of 16 tests, each of 4 hours duration. Once the program was underway, 13 successful tests were completed.

The monitored parameters for these 13 tests included:

1. combustion air flow
2. boiler and stack temperature
3. residence time
4. CO, HC, O_2, and CO_2 concentrations in the boiler
5. stack emissions and flow rates.

The test results for the 13 tests are given in the following table:

Emission Test Results (13 Tests)

for SWARU

	Equivalent Dioxin Emission Rates ug/sec	Stack Temp. ^{o}C	Maximum Ground Level Concentration (Calculated from Emission Rates) pg/m^3
Average	48	295	191
Range	21-129	250-324	77-446

Complete details of these tests and the test results are presented in two Ministry reports:

1. Report on Combustion Testing Program at the SWARU Plant, Hamilton-Wentworth

2. Determination of Chlorinated Dibenzo-p-Dioxins, Chlorinated Dibenzofurans, Chlorinated Biphenyls, Chlorobenzenes and Chlorophenols in Air Emissions and Other Process Stream at SWARU in Hamilton.

In January, 1984, the Ministry of the Environment released a "Status Report on the Solid Waste Reduction Unit (SWARU) - Dioxin Test Project at Hamilton". On the basis of the test data, it was concluded that SWARU be operated safely and that the ambient air concentrations of dixoins and furans could be maintained within the limits of the provisional guideline.

SWARU has recently therefore returned to its former throughput rates and will be required to meet the operating conditions which were appended to the Certificate of Approval.

Particulate emissions remained a problem at SWARU. The Ministries of Energy and Environment jointly funded an engineering study of the problem. A consultant considered 7 alternative control techniques and subsequently recommended an evaporative spray tower and fabric filter to replace the existing electrostatic precipitators. The consultant also recommended changes to the feed handling and combustion air systems. The Regional Municipality has accepted these recommendations and a funding formula is presently being worked out.

FURTHER WORK

This work is at the leading edge of research and our efforts are still ongoing in this area. Some of our present work includes:

1. Continued detailed analysis of the SWARU test results
2. The Energy and Environment Ministries partially funded emission testing of a Japanese incinerator as part of a cooperative program with the California Air Resources Board. The incinerator is equipped with a lime spray tower/baghouse emission control system. Two Environment staff members witnessed the test program. A report is expected soon from California.

3. Supporting further research at the University of Waterloo:

   (a) the physical state (vapor or particulate) of dioxins in the flue

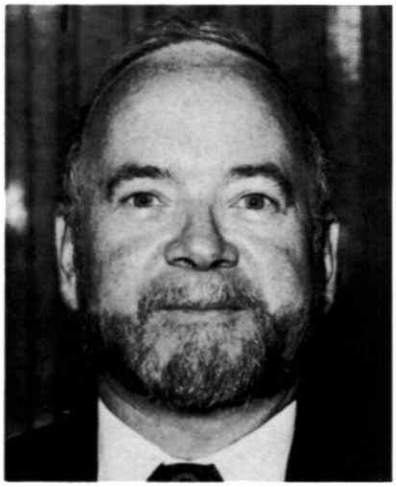
   (b) leachability of dioxins from precipitator fly-ash.

CONCLUSION

Results of the testing progrm show that Energy-from-Waste incinerators can be operated safely with regard to air emissions. The information gathered during this program will be extremely useful in evaluating environmental assessments for future Energy-from-Waste facilities.

Finally, Energy-from-Waste incinerators are seen as a major component of Ontario's waste management program.

SESSION IV – ENERGY FROM WASTE – CONCLUSION



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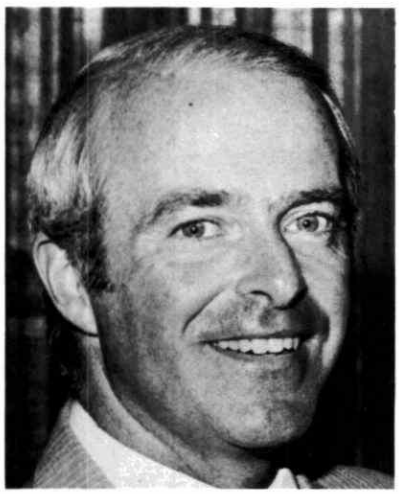
Environmental Approvals &
Project Engineering Branch,
Ontario Ministry of the Environment,
Toronto, Ontario



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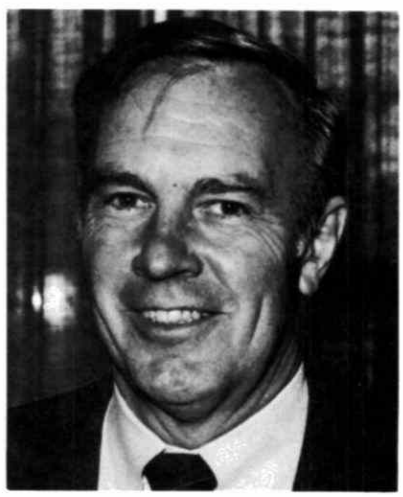

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THE REGIONAL MUNICIPALITY OF WATERLOO-LIVING WITH THE 4R's

by

J.D. Pawley, Director of Engineering Operations,
Regional Municipality of Waterloo, Waterloo, Ont.

1. INTRODUCTION

The Regional Municipality of Waterloo, with a current population of approximately 306,000 persons, is located in South Central Ontario. The Region has a pleasant mix of highly developed urban areas, such as the Cities of Kitchener, Waterloo and Cambridge, prime agricultural land. In the rural areas, several satellite communities serve the agricultural community.

As in all modern urban and rural communities, solid and liquid wastes are generated and their disposal, in an environmentally and socially adequate way, presents the same problems as those found in more densely populated and highly industrialized communities.

In this paper, certain aspects of the solid and liquid waste management programs being undertaken by the Regional Municipality of Waterloo will be examined. While the total program will be described, emphasis will be on those initiatives which have resulted in, or will result in, waste reduction, recycle, reuse and recovery.

2. THE 4Rs IN SOLID WASTE MANAGEMENT

(a) The Master Plan

In 1983, the Regional Municipality of Waterloo embarked upon a detailed Waste Management Program. This Program, in the study stages, will be made up of two facets:

1) A Master Plan,

2) Site Specific Designs.

An innovative element of the Waste Management Program is the approach which will be followed with respect to its submission to the Ministry of the Environment for approval. Here, it is the intention that the Master Plan Report will be considered as an Environmental Assessment Report as defined by the Environmental Assessment Act and will be subjected to public hearings as required by that Act.

This action has been initiated in an effort to streamline the environmental approval process with respect to the various site activities which must take place within the next 20 to 30 years to create a rational and environmentally safe plan for the disposal of solid wastes within this Region. It is felt that if sufficient information can be incorporated into the Master Plan to satisfy all objectives of the Environmental Assessment Act, those favoured alternatives can receive Environmental Asssessment Act approval in terms of the Master Plan objectives, with the Site Specific approvals requiring only approvals under the Environmental Protection Act.

While there is an element of chance in this procedure, as there are no guarantees that a Site Specific project will not be bumped to a full hearing under the Environmental Assessment Act, it is felt that this is a preferred course of action. To take each Site Specific activity through the Environmental Assessment process would be equally risky as the failure of one element to receive approval could result in the complete collapse of the Master Plan. Unfortunately, but as may be expected, up-front consulting costs for this process are significantly higher and it remains to be seen if this objective can be accomplished.

An integral part of the Master Plan process will be an in-depth review of the opportunities within the Region for alternative processing and disposal methods. While the public participation part of the Waste Management Program has been minimal to date, there is one singular message being received from those interested in waste disposal practices. That is, "All efforts must be made to reduce future dependence on the conventional landfill practices."

In this regard, the Master Plan work outline includes the following tasks:

(i) Review of potential energy users.

(ii) Assessment of waste reductions on future quantities.

(iii) Economic evaluation of resource recovery options.

(iv) Review of potential recovered material users. (Both inside and outside the Region.)

(v) Determine source separation alternatives.

(vi) Identify options.

While many alternatives for recovery-reuse will be examined such as Composting, Hydropulping, Shredding, etc., it is expected that the Master Plan will stress as most important and immediately achievable the alternatives of "Energy From Waste" and "Source Separation" with Material Recovery. These alternatives have been studied extensively and a pilot "Source Separation" program has commenced as described below.

(b) Energy From Waste

In the Phase I Report of the Master Plan, which is currently under public review, major steam users in the Region have been identified as possible participants in an E.F.W. project where municipal refuse could be incinerated and energy recovered in the form of steam.

The feasibility of such a project, however, has been extensively studied by the Region in association with B. F. Goodrich (Canada) Inc., the Ministry of Energy and the Ministry of the Environment. Following successful installation of E.F.W. facilities adjacent to B. F. Goodrich plants in the United States, Senior Canadian plant managers suggested that consideration be given to the location of a 270 tonne per day plant on land dedicated by B. F. Goodrich adjacent to the Tire Products plant in Kitchener.

Following extensive review by the multi-agency project team, the project was turned over to B. F. Goodrich in an effort to "fast-track" the project and to avoid several bureaucratic hurdles. At this time detailed "full service" proposals from 3 prospective owners are being considered by B. F. Goodrich corporate staff.

Regional staff are confident that this project will proceed and that the Master Plan can be completed including incineration and heat recovery in the long-term strategy for Regional waste disposal. Of course, opportunities for other similar projects in the Region will be pursued.

(c) Source Separation and Material Recovery

The initiative for source separation rests almost entirely with the firm of Total Recycling Systems Limited of Kitchener. This firm, who is associated with Laidlaw Waste Systems Limited (contractors for municipal waste collection in the City of

Kitchener), has initiated a pilot project to assess the possibilities of instituting a full scale source separation program in this and other Canadian communities. The pilot program is funded in large part by the Ministry of the Environment and will cover a 3 year period.

The Kitchener source separation program now serves about 75% of all residents including 3,000 apartment units. To initiate this program, coloured recycling containers were provided to each household in the participating area. Instructions were left with the householder on how to prepare the newspapers, glass bottles and cans and in which containers the materials should be placed.

To date, since program initiation in September, 1983, 4,600 tons of newspaper, cans and bottles have been recycled and sold. In terms of the environment this represents the saving of 50,000 trees and 8,000 cubic yards of landfill.

Not satisfied with this effort, Total Recycling Systems is currently initiating two new important programs in Kitchener:

(i) Home composting.

(ii) Used oil collection.

To encourage composting of home wastes, the company has obtained Katimavik volunteers to build composters from recycled drums obtained following use in the food industry. The first 1,000 composters manufactured will be offered free on a "first come first served" basis.

The collection of "used oil" is being added to the weekly curb side pick-up program. Instructions for the placement of the oil in clean 4 litre jugs have been circulated to Kitchener homeowners. The used oil is then sold to "CANAM Oil Services" for re-refining at the Breslube-CANAM refinery near Breslau.

In order to keep the Kitchener residents fully informed of the varous programs and the success of each, a newsletter entitled "The Total News" is published quarterly. This newsletter contains "how to" articles on recycle-reuse, discusses the processes of recovery of some of the products sold and reports on accumulated savings in terms of environment or landsfill space.

It is interesting to note that the innovative and aggressive source separation and recycling programs instituted by Total Recycling Systems in Kitchener is kindling the interest of politicians in other area municipalities. Other refuse collection companies, under contract with the area municipalities, are now being asked to consider source separation alternatives.

Unfortunately, the Regional Municipality of Waterloo is structured on a two-tier system with the Region responsible only for waste disposal. Thus, the area municipalities must volunteer effort to reduce waste with the major benefactor being the Region. While it is not expected that this situation will

change, Regional staff feel that in the future, the upper tier can contribute in terms of publicity, promotion, educational programs.

(d) Public Participation and Input

While public participation is now encouraged at open houses and public meetings as a matter of course in the preparation of the Master Plan, the Council of the Regional Municipality of Waterloo recognized the value of public participation and input as early as 1977.

At this time, a "Waste Management Advisory Committee" was established to review and respond to the various waste management alternatives being proposed and to review and maintain an up-to-date knowledge of waste disposal alternatives. This Committee, the members of which comprise of a cross-section of the community, have reviewed refuse sorting and material recovery at landfill sites, shredding and recovery of rubber product wastes, energy from waste alternatives and source separation programs.

While Committee members recognize the need for landfill for some wastes, they continue to stress the need for more attention in the area of the 4Rs.

It is expected that the next venture of the "Waste Management Advisory Committee" will be a consideration of educational programs both in the school system and to the populace as a whole. Regional staff strongly supports this concept and feel that it would even be more effective if the Province were to become more involved in this issue.

3. THE 4Rs IN LIQUID WASTE MANAGEMENT

(a) The Liquid and Special Waste Study

One of the most gratifying aspects of the municipal engineering vocation in the Regional Municipality of Waterloo is the tremendous "grass-roots" support both of the public and industry in programs designed to improve the physical or social environment.

Evidence of this support surfaced in 1980 when the local Chambers of Commerce and Boards of Trade together with Provincial and Regional officials initiated an "Information Transfer Seminar" for local industries relating to industrial waste disposal problems.

This seminar was highly sucessful and in response to the indicated need of local industries, the combined "Chambers of Commerce and Boards of Trade" formed a "Waste Management Committee" to assist in the development of a cohesive approach to industrial waste disposal problems.

Early in their deliberations, Committee members decided that the magnitude of the problem in the Region would remain unkown until a survey of the types and quantities of liquid and special wastes could be undertaken. Subsequently, a request by the "Waste Management Committee" was received by Regional Council for funding support relating to a Liquid and Special Waste Inventory Study. Regional Council then solicited support for such a study from the Ministry of the Environment and Environment

Canada. These agencies were tremendously enthusiastic about the project and the final funding agreement was as follows:

Environment Canada	$ 7,500
Ministry of the Environment	$30,000
Regional Municipality of Waterloo	$ 7,500
Chambers of Commerce	$ 5,000
TOTAL	$50,000

To administrate the study, a Project Team was established and the firm of Canviro Consultants Limited was chosen to carry out the work. This was successfully achieved within the project budget and on time.

From the "Liquid and Special Waste" Study, several recommendations resulted with respect to the management of these wastes in the Region. Those which particularly included elements of the 4R philosophy were:

(i) Analyse the cost effectiveness and environmental acceptability of the existing liquid waste management systems as opposed to:

- Volume reduction of existing wastes.
- Inter-industry waste exchange.
- Inter-industry co-operation in the treatment of similar wastes.
- Recycling of wastes at the source.
- Provision of Regional recycling centres for specific wastes.
- Provision of additional services by the private sector such as mobile recycling, recovery and treatment systems.

(ii) Implementation of a "hot-line" to make specific information available to waste generators on liquid and special waste management solutions including opportunities to reuse-recycle options.

(iii) Utilization of the study information to support the "Liquid and Special Wastes Technology Study" as proposed by a consortium including Resource Integration Systems Inc., Ontario Research Foundation, Hans Mooij & Associates, and Proctor and Redfern Limited.

Action on several of these items has been initiated by Regional staff and the R.I.S. project has proceeded as described below.

(b) Liquid and Special Waste Technology Study

As mentioned above, the "Liquid and Special Wastes Technology Study" fell "hard on the heels" of the Regional inventory. The Region was a particularly suitable venue for this study because a great deal of accurate up-to-date information was available on liquid and special waste quantities and there was a demonstrated awareness and support for further management alternatives by local industry.

The "Technology Study" was co-funded by Environment Canada and the Ministry of the Environment ($229,000 Federal - $18,000 Provincial). The objectives of the "Technology Study" were:

1) To study the potential for and benefits of reduction, reuse, and recycling processes in relation to industrial waste streams.

2) To develop information detailing technologies available to achieve reduction, reuse, and recycling of these wastes, and to analyze and outline the economics of these technologies.

3) To analyze the factors which have been instrumental in past decisions by industries which have adopted such processes, and to outline the methods and factors which have been most effective in achieving adoption.

4) Based on this previous work and other knowledge and experience, to design and implement a community-based demonstration program in the Region of Waterloo.

5) To evaluate the results of the demonstration, and other information and technology transfer techniques which work on a sectoral rather than municipal scale, in order to develop a recommended plan of action for Ontario and Canada.

The administration of this study was placed in the hands of a Technical Steering Committee with representation from:

Environment Canada

Ministry of the Environment

Chamber of Commerce

Regional Municipality of Waterloo.

Following a great deal of discussion and activity, the tenor of this study has changed somewhat so that the general name of the on-going work is "Industrial Waste Prevention: An Assessment and Demonstration Program in the Region of Waterloo".

To date, the following results have been recorded:

(i) Industrial Manuals for reuse, recycle and reduction options have been produced for six specific industrial sectors.

(ii) A "Newsletter" focussing on industrial waste reduction endeavours in the Region has been produced and several successful mailings have been sent.

(iii) A survey of local needs with regard to a liquid transfer station for small volume generators has been performed.

(iv) An inter-industry waste exchange in the Region has been developed and is working successfully. It is being integrated into the National Waste Exchange.

(v) A "Hot Line" has been set up at the Region's Laboratory where information on waste problems in general can be obtained. The focus of information is reuse, recycle, reduce.

(vi) Seminars have been held with various industry sectors to introduce the manuals and encourage feedback on their effectiveness.

It is expected that this "Demonstration" project will conclude in mid-1984 with the submission of a formal report by the consultants. Regional staff are confident that the material produced during this study will be useful on a nation wide basis. It is certainly the intent of Environment Canada staff to utilize it in this manner.

(c) Private Sector Initiatives

There are several excellent examples of private sector involvement in liquid recycle-use schemes in the Region of Waterloo. Among these are:

(i) Breslube-CANAM

Re-refines 6 million gallons of waste oil per year. A production increase to 13 million gallons per year is anticipated.

(ii) H & O Centreless Grinding

Waste cutting oil is recovered from residues on the scrap metal. Approximately one drum every three weeks is recovered in this way.

(iii) K-W Record

Printing ink residues previously left in the barrels are recovered for use. Two gallons of printing ink per month is reclaimed and the barrels are now suitable for disposal at the Regional Landfill Sites.

(iv) Weston Bakeries

Waste solids collected in treatment pits are removed and taken for use as animal feed. Approximately 1,000 pounds of animal feed per week is recovered.

(v) Woolwich Dairy

Approximately 1,000 pounds per week of liquid whey are recovered and transported to a pig farm for feed.

(vi) Frito-Lay

Approximately 2,000 pounds per day of waste solids are recovered for use as pig feed.

(vii) Automotive Component Plant

Waste oils are collected in treatment interceptors and picked up for reclaim. Approximately 3,000 gallons are sent for reclaim every two weeks.

(viii) Waste Solvent Recovery

A firm picks up waste solvents, approximately 10,000 gallons per week, for distillation and reuse.

4. RECOVERY AND USE OF LANDFILL GAS

The former Kitchener Landfill Site, closed in 1974, is ideally situated with respect to a major energy user, Bestpipe, a division of Lake Ontario Cement Limited. At Bestpipe, concrete pipe products are manufactured with large amounts of steam utilized in the curing process.

In 1981 Bestpipe, through the firm of Conestoga-Rovers and Associates, approached the Region with the suggestion that the feasibility of the recovery of landfill gas be considered for sale to the company at an appropriate cost.

Subsequently, funding support from Environment Canada was received under the D.R.E.C.T. program (Demonstration of Renewable Energy Conservation Technologies) and from the Ontario Ministry of Energy.

In 1982, Phase I of the project was completed at a cost of $420,000. This involved the construction of 15 gas wells, collection and distribution mains, a pumping station and associated drying and control equipment.

Since that time an additional $70,000 has been spent in order to augment gas production and at the present time landfill gas is being supplied on a daily basis to one of two 100 H.P. Cleaver Brooks boilers at Bestpipe.

In 1984 Phase II of the project will commence. This will involve the construction of additional gas wells, increased pumping station capacity and the equipping of the next 100 H.P. boiler at Bestpipe to receive landfill gas. The cost of Phase II is estimated at $184,000.

5. SUMMARY

While some success in terms of waste reuse, recovery, reduction and recycling have been demonstrated in this Region, it is only a beginning. Instead of Living with the 4Rs social changes must take place so that we Live the 4Rs. This will require life-style changes that many may resist initially, however, with continued public education and demonstration programs, with emphasis on education in the public schools, and with continued strong political support for the exciting alternatives available, solid and liquid waste disposal should not be an environmental issue in the Region in the future.

ENERGY FROM WASTE IN A CEMENT KILN

by
A.F. Robb, Plant Manager, Canada Cement Lafarge Ltd., Woodstock, Ontario

Over the last number of years, our company and, the Lafarge group generally, has done a great deal of work on non-conventional sources of heat for its rotary cement kilns. Today I am going to describe a project at our Woodstock, Ontario cement plant which, I hope, will result in the use of selected liquid industrial wastes as a supplementary fuel. At the present time we have concluded a three month test burn and are preparing for an environmental assessment hearing under the Environmental Protection Act which will likely be held in the fall of this year. If we are successful at the hearing, and if permanent permits are granted, we will proceed with the use of this waste as fuel to supply up to 40% of the heat requirements of our two kilns.

WHAT IS THE MATERIAL WE PROPOSE TO USE?

The selected waste is mainly solvents from five industrial groups: automotive
paint and coating
ink and printing
cosmetics
and photographic
as well as other smaller generators and reprocessors. The waste is carefully controlled by specification and by rigorous

laboratory quality assurance procedures. The specification excludes: PCBs

and limits:

Benzene	0.5%
Lead, Barium, Chromium, Zinc	
Halogens	2%
Sulphur	3%
Nitrogen	1%

We have contracted with an experienced and respected waste management firm, Systech Corporation of Xenia, Ohio to acquire the fuel and to carry out all quality assurance procedures. These include:

- prequalify each supplier from samples submitted by the generator
- analyzing a sample from each truck before it is allowed to unload.
- analyzing each tank of fuel before it is tendered to Canada Cement Lafarge.

HOW IS CEMENT MADE? WHY DOES IT REQUIRE SO MUCH FUEL?

For the sake of clarity, I am discussing the manufacture of cement - the fine powder used along with aggregates to make concrete. Cement is made in four distinct stages:

1. the preparation of the raw materials which in our case entails the quarrying of limestone and the washing of clay.
2. the grinding of the raw materials into a feed mix for the kiln. In our case the feed mix is a slurry as our plant employs the wet process.
3. the heating of the raw materials gradually to 2600^{o}F or 1400^{o}C to produce clinker. It is this process which we call "Burning" that requires considerable heat and which is the focus for this project.
4. the grinding of the clinker, with gypsum, into the fine powder which we call cement.

In our wet process the heat is required for the following changes to take place:

1. the water of the slurry is evaporated and discharged up the stack as water vapour.
2. the limestone is heated to a point where calcining takes place. This is the breakdown of the calcium carbonate (limestone) into calcium oxide and carbon dioxide which is discharged up the stack.
3. the feed mix is further heated on its way down the rotating kiln until the original compounds containing, primarily, silica, iron, alumina and lime are transformed into new compounds which give the cement its necessary characteristics for strength, strength gain, soundness etc.

This transformation takes place at about 1400^{o}C and requires a flame of about 1700^{o}C. The cement kiln provides an exceptional burning environment for the use of waste as a fuel. The high temperature, the extreme turbulence and the long retention time assure that the fuel is consumed in an environmentally safe manner.

The clinker so produced is then cooled in an air quench cooler before being transported to storage.

This has given you a quick summary of:

- the manufacture of cement
- the requirement for fuel and the heat derived from it
- our proposal to use selected liquid industrial waste as a fuel

Before proceeding further I would like to show you a few slides that may help you to visualize better what I have been and will be talking about.

Slide # 1 - view of our plant on Highway #2 west of Woodstock showing the kiln stacks, one of the kilns and some of our cement storage silos.

2 - view of the kilns and related equipment from the stacks to the clinker coolers.

3 - schematic of the kiln system showing the sampling points.

4 - schematic of plant layout

5 - view of our two 450' x 12' diameter rotary cement kilns each capable of producing 225,000 tonnes of clinker/year.

6 - liquid fuel storage area showing the two tanks used during the test burn. We propose expanding the facility to 10 tanks.

7 - liquid fuel storage tanks with pumping and straining enclosure.

8 - liquid fuel storage tanks with side-mounted agitators and containment berm.

9 - unloading point for trucks with strainers.

#10 - kiln fuel supply pumps and strainers

#11 - truck being sampled by a Systech technician prior to unloading.

Slide #12 - view along kiln # 1 - route of the fuel supply piping
- dust tank for waste dust.

#13 - interior of plant lab showing some of Systech's equipment.

#14 - Systech technician preparing a sample under the fume hood.

#15 - Ontario Research Foundation lab truck during testing.

#16 - ORF technician in lab truck.

TEST BURN

A test use of this liquid waste as fuel was carried out in late 1983 under three temporary permits issued by the Ontario Ministry of the Environment. During the test firing we used about 260,000 gallons of liquid waste along with delayed petroleum coke which has been our primary fuel since 1979. The liquid waste replaced natural gas in the kiln.

Prior to the test, extensive discussions took place between various branches of the MOE, our monitoring contractor - the Ontario Research Foundation, Environment Canada and ourselves. These discussions led to the establishment of a test protocol that was carried out during a portion of the test. The protocol called for a series of tests at 0% use (baseline), 20% heat replacement and 40% heat replacement on the following emissions:

- from the kiln stack
  - trace metals
  - trace organics (Dioxins, Furans)
  - particulate material
  - chlorine species
  - gases
- from the clinker cooler stack
  - trace metals
  - particulate material
- kiln dust wasted to landfill
  - leachate toxicity
  - trace metals
  - oxides
- clinker cooler dust
  - leachate toxicity
- clinker produced
  - trace metals
  - oxides
  - free lime
- cement
  - oxides
  - usual cement quality tests

Tests were carried out on the feed streams:

- feed mix
- petroleum coke
- liquid waste

MONITORING PROGRAM

Baseline monitoring was conducted by the Ontario Research Foundation in late August and early September before any liquid waste had been used as fuel.

Testing at 20% heat replacement was carried out in mid October.

Testing at 40% heat replacement was carried out in late October.

The test burn continued on an intermittent basis until the end of the year so that we could:

- establish suitability of installed equipment
- assess plant operating procedures
- carry out testing related to employees occupational health and safety.

In addition, ORF carried out ambient air monitoring for total hydrocarbons in the tank storage area during filling operations. There were no significant levels of hydrocarbons detected. ORF also carried out monitoring on employees working in the area for toluene and xylene, the most prevalent solvents in the fuel mix.

The environmental monitoring has been an important aspect of this project. It is not the only monitoring done nor is this topic our only area of concern.

We have stated from the outset that we want to ensure that our project does not adversely affect:

- the environment
- our employees
- our product
- our process and equipment

Our employees, through the local union, have been involved from the outset. Procedures were developed and protective equipment was provided to ensure that employees would not be unduly exposed to the fuel or its fumes during the test. Results of our testing has indicated that many of these precautions may be relaxed but this will be reviewed before we resume burning this fuel.

Over the period of the test burn, the Ontario Ministry of the Environment carried out air quality tests at the plant perimeter and in the plant neighbourhood using a mobile lab. One summary statement in the MOE report on this monitoring indicates that air quality for measured parameters downwind of our plant is significantly cleaner than that of downtown Toronto. The MOE also carried out spot checks on the fuel received at the plant.

The Ontario Research Foundation carried out all field sampling on our behalf. It also carried out all analytical work on the samples except the analytical work to determine the presence of dioxins and furans. Analysis of samples for dioxins and furans was undertaken by Xenon Environmental Laboratories. The samples that were analyzed for dioxins and furans were split with the MOE conducting an analysis on the half sample.

RESULTS OF THE MONITORING

The report from ORF was completed in late May of this year and distributed to interested parties on 1 June.

I will read from the summary of the report.

"A comparison of component emission rates for the kiln stack utilizing liquid waste as a partial fuel with emission rates for the kiln stack using only petroleum coke as a fuel indicates the following:

- emission rates of particulate material decrease and show a decreasing trend with increasing liquid waste usage.

- emission rates of the trace metals cadmium, chromium, copper and zinc remain unchanged or decrease.

- emission rates of trace metals barium and lead increase.

- emission rates of sulphur dioxide and nitrogen oxides decrease.

- emission rates of chlorides and total hydrocarbons increase and show an increasing trend with increasing liquid waste usage.

For all these components, using maximum emission rates, computed point of impingement concentrations are well below current maximum values permitted in Ontario Environmental Protection Act regulations.

Emission rates of dioxins and furans ranged from 0.17 micrograms per second (ug/s) to 1.82 ug/s and from 0.12 ug/s to 3.25 ug/s respectively. There is no significant difference in emission rates of these compounds when the kiln is using only petroleum coke as a fuel or using petroleum coke and liquid waste as a fuel. Computed point of impingement concentrations of dioxins and furans, using maximum emission rates for these components, are well below current Ontario Ministry of the Environment guidelines.

At the clinker cooler, measured stack emission rates of particulate material and trace metals did not increase with the use of liquid waste. Although calculations were not carried out, it is expected point-of-impingement concentrations would also be well below the permitted maxima since emission rates of these components were significantly lower than corresponding emission rates from the kiln stack.

Chemical and physical analyses of the kiln clinker and cement samples indicated there is no apparent change to these products when liquid waste is used as a replacement fuel in the rotary kiln. All samples were within specifications where these were given for various ASTM and CSA physical analyses.

Samples of kiln waste dust and clinker cooler dust were analysed using an Ontario Ministry of the Environment leachate toxicity test for specific organic compounds, trace metals and inorganic compounds. Analyses of two kiln waste dust test samples, collected when 40% liquid waste fuel was being burned, indicated levels of cadmium were sufficiently high that disposal of this dust in a secure landfill site would be necessary. It is, however, the intention of CCL to dispose of all kiln waste dust in a secure landfill site. Results for the same test carried out on samples of clinker cooler dust indicated this material does not need to be disposed of in a secure landfill site.

Ambient concentrations of hydrocarbons in the vicinity of the liquid waste storage tank area during liquid waste handling ranged from 0 - 4 ppm.

Overall, it appears there are generally no significant increases in the emissions from the kiln stack and cooler stack during the use of liquid waste fuel, nor does there appear to be any adverse effects on the plant products."

I will show you slides of some of the results of the monitoring program from the ORF report.

Slide #17 - Test schedule - key to test numbers

#18 - Kiln Stack Particulate Concentrations and Emission Rates
- note decrease in particulate emission with use and increased use of liquid waste as fuel.

#20 - Kiln Stack Gaseous Contaminant Emission Rates
- note - increase in total hydrocarbon with increased use of liquid fuel
- decrease in Sulphur Dioxide and Nitrogen Oxides

#21 - Kiln Stack Chloride Concentrations and Emission Rates
- note - increase in Chloride Emission Rates with increased use of liquid fuel

#22 - Kiln Stack Dioxin and Furan Concentrations
#23 -
- note - appearance of very small concentrations and emission rates during all tests including baseline
- no apparent pattern of increase or decrease

#24 - Kiln Stack/Cooler Stack Trace Metal Emission Rates
- note - cadmium, chromium, copper, zinc show no change or decrease
- barium and lead increase

#27 - Kiln Stack - Comparison of Calculated and Regulated Impingement Concentrations
- note - all calculation are based on "worst case" results
- all "worst case" results are well below the regulated impingement concentrations with the closest being PARTICULATES and NITROGEN DIOXIDE at 30% of the regulation.

Slide #27 (continued)

- trace metals are at 1% or less of regulation.
- Dioxins are at about 1% of regulation.
- Furans are at well under 1% of regulation.

Slide #28 - Ontario Drinking Water Quality Criteria

- wide range of compounds and elements
- results of analysis or leachate is compared to 100 times the concentrations listed.

Slide #29 - Kiln Waste Dust - Leachate Analysis for Organics
#30 at Base, 20%, 40%
#31

- note - few random detections at very low levels.

Slide #32 - Kiln Waste Dust - Leachate Analysis for Organics
#33 at Base, 20%, 40%
#34

- note - at 40% fuel use
  - cadmium concentrations of 0.84 and 0.97mg/l
  - ODWC is 0.005 mg/l
  - standard is 0.5 mg/l (100 times)

SECURE LANDFILL

The only result that has adversely affected the project is that of cadmium in the leachate of the wasted kiln dust at 40% heat replacement. On two of the tests at this level the concentration of cadmium exceeded the criteria of 100 times the Ontario Drinking Water standard for that metal. This is shown on the next slide.

We became aware of this result in the spring and have undertaken a hydrogeological study of the plant landfill using the services of MacLaren Plansearch. MacLaren will also prepare a landfill development plan. Neither the hydrogeological study nor the plan are available yet but are due by the end of this month.

Our application for a permit for our landfill will be reviewed at the environmental assessment hearing looking into other aspects of the project.

PUBLIC INFORMATION

One of the groups interested in our project is Environment Canada. Under its DRECT program, $ 350,000 has been granted toward this project. One of the main emphases on Environment Canada is that of public information.

The amount and quality of public information is hard to assess. The critics of our project may feel that our public information program has been inadequate. This project has been going through an evolution for over 1½ years now. There have been long periods during that time when there has been nothing to report. The time for the determination of the test protocol is an example as is the five month period from the end of the test burn to the release of the monitoring report. There have also been delays due to plant operating conditions.

Through this slow, methodical and deliberate approach to the project, our company has made a substantial effort to keep interested parties and the public in general informed.

In early 1983 we advised all municipal representatives, health officials and local politicians of our plans. During the same period we met with environmental interest groups. In early March 1983 we held a public information meeting in Embro, Ontario, a nearby community. During the test burn we held an Open House over two months. This gave interested people and groups an opportunity to see as well as hear what was going on at the plant.

The local newspapers have been following the project closely and have been giving fair coverage when there have been events to report.

It is essential that projects of this sort be kept open to attempt to allay the concerns that are bound to crop up in the minds of many.

CONCLUSION

Our process is a long way from being over. We have never been to an environmental assessment hearing and so do not have first hand knowledge on what to expect.

I was relieved however in reading the results of the monitoring conducted by the Ontario Research Foundation. Some of the results were somewhat surprizing - like the appearance of dioxins and furans in the stack emissions - but all the comparisons to environmental standards were met with ease except the one result in the kiln waste dust.

This has confirmed the results of projects in the United States and Scandinavian countries where cement kilns have used liquid industrial waste as fuel for a number of years.

There is a clearly emerging picture that cement kilns are well suited to use a range of liquid industrial wastes as fuel. This is good for cement plants as it makes less expensive fuel available and will help to control costs. It is also good for industries generating or reprocessing waste as they will have another outlet - and more important, an Ontario outlet - for their waste. It is also good for Ontario as there is, what I hope will be concluded, one more environmentally sound method of disposing of some of our waste.

SLIDES

NO.

1. VIEW OF WOODSTOCK PLANT FROM FRONT ENTRANCE
2. VIEW OF KILNS FROM STACKS TO CLINKER COOLERS
3. SCHEMATIC OF SAMPLING POINTS (ORF REPORT FIGURE 3)
4. SCHEMATIC OF PLANT LAYOUT
5. TWO KILNS FROM BURNER FLOOR
6. LIQUID FUEL STORAGE AREA
7. LIQUID FUEL STORAGE TANKS AND PUMP/STRAINER ENCLOSURE
8. LIQUID FUEL STORAGE TANKS WITH AGITATORS IN CONTAINMENT BERM
9. UNLOADING POINT WITH STRAINERS
10. KILN FUEL SUPPLY PUMPS AND STRAINERS
11. TRUCK BEING SAMPLED PRIOR TO UNLOADING
12. VIEW ALONG KILN # 1 - ROUTE OF FUEL SUPPLY PIPING
13. INTERIOR OF PLANT LAB - SOME OF SYSTECH'S EQUIPMENT
14. SYSTECH TECHNICIAN PREPARING SAMPLE IN FUME HOOD
15. ONTARIO RESEARCH FOUNDATION LAB TRUCK AT BASE OF STACK DURING SAMPLING.
16. ORF LAB TRUCK INTERIOR

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TABLE 10

CANADA CEMENT LAFARGE - 1983

KILN STACK TEST SCHEDULE

Test Number	Test Date	Sampling Time*							
		Traverse No.1		Traverse No.2		Traverse No.3		Traverse No.4	
		Start	Finish	Start	Finish	Start	Finish	Start	Finish
1	Aug.30, 1983	11:15	12:15	12:55	13:55	15:20	16:20	17:05	18:05
2	Sep. 2, 1983	10:50	11:50	12:20	13:20	14:20	15:20	15:50	16:50
3	Sep. 3, 1983	9:50	10:50	11:35	12:35	13:35	14:35	15:20	16:20
4	Oct.12, 1983	10:35	11:35	13:55	14:55	16:50	17:50	18:30	19:30
5	Oct.13, 1983	11:05	12:15**	13:50	15:40***	16:25	17:25	18:15	19:15
6	Oct.18, 1983	9:45	10:45	11:20	12:20	15:20	16:20	16:45	17:45
7	Oct.20, 1983	9:55	11:15****	11:50	12:50	13:55	14:55	15:30	16:30
8	Oct.21, 1983	9:55	10:55	11:15	12:15	12:45	13:45	14:10	15:10
9	Oct.22, 1983	8:55	9:55	10:25	11:25	11:55	12:55	13:30	14:30

* To Nearest 5 min.

** 10 min. Pause in Sampling Due to Process Malfunction

*** 50 min. Pause in Sampling Due to a Thunderstorm.

**** 20 min. Pause in Sampling Due to Equipment Malfunction

TABLE 16

CANADA CEMENT LAFARGE - 1983

KILN STACK PARTICULATE CONCENTRATIONS AND EMISSION RATES

Test Number	Particulate* Concentration	Stack Gas* Flowrate	Particulate Emission Rate
	mg/m^3	m^3/s	g/s
1	232.5	29.5	6.86
2	147.8	27.6	4.08
3	105.7	28.2	2.98
4	100.3	28.9	2.90
5	80.5	27.4	2.21
6	82.5	29.2	2.41
7	56.2	29.1	1.63
8	51.0	28.7	1.46
9	84.2	30.5	2.57

*At Dry, Reference ($25^{o}C$, 1 Atmosphere)

ORF

TABLE 47

CANADA CEMENT LAFARGE - 1983

KILN STACK MAJOR GASEOUS COMPONENT EMISSION RATES

Test Number	Stack Gas Flowrate*	Major Gaseous Component Emission Rates		
		Oxygen kg/s	Carbon Dioxide kg/s	Nitrogen kg/s
1	29.7	3.86	8.41	25.30
2	28.2	3.58	8.07	24.03
3	28.3	3.82	7.78	24.11
4	29.0	4.03	7.77	24.74
5	27.4	3.48	8.14	23.15
6	28.5	3.88	7.89	24.23
7	30.2	4.14	8.43	25.58
8	29.4	3.97	8.35	24.87
9	31.3	4.41	8.61	26.48

* At Dry, Reference (25^{o}C, 1 Atmosphere)

ORF

TABLE 46

CANADA CEMENT LAFARGE - 1983

KILN STACK GASEOUS CONTAMINANT EMISSION RATES

Test Number	Stack Gas Flowrate*	Gaseous Contaminant Emission Rate		
		Total Hydrocarbon**	Sulfur Dioxide	Nitrogen Oxides***
	m^3/s	mg/s	g/s	g/s
1	29.7	416	58.1	37.9
2	28.2	386	39.5	47.2
3	28.3	283	55.3	35.7
4	29.0	629	5.5	25.1
5	27.4	803	34.2	23.6
6	28.5	553	32.2	29.3
7	30.2	776	34.7	32.0
8	29.4	709	48.6	21.2
9	31.3	808	37.7	20.8

* At Dry, Reference (25^oC, 1 Atmosphere)

** As Methane (CH_4)

*** As Nitrogen Dioxide (NO_2)

ORF

TABLE 51

CANADA CEMENT LAFARGE - 1983

KILN STACK CHLORIDE CONCENTRATIONS AND EMISSION RATES

Test Number	Chloride* Concentration	Stack Gas* Flowrate	Chloride Emission Rate
	mg/m^3	m^3/s	g/s
1	21.40	29.7	0.636
2	17.31	28.2	0.488
3	34.28	28.3	0.970
4	36.69	29.0	1.064
5	51.53	27.4	1.412
6	51.44	28.5	1.466
7	106.99	30.2	3.231
8	88.77	29.4	2.610
9	92.94	31.3	2.909

*At Dry, Reference ($25^{o}C$, 1 Atmosphere)

TABLE 42

CANADA CEMENT LAFARGE - 1983

KILN STACK DIOXIN AND FURAN CONCENTRATIONS

Test Number	Quantity Detected		Volume of* Gas Sampled	Concentrations	
	Dioxins ng	Furans ng	m^3	Dioxins ng/m^3	Furans ng/m^3
1	47.4	259.8	2.475	19.2	105.0
2	7.7	76.0	2.372	3.2	32.0
3	8.8	9.5	2.333	3.8	4.1
4	158.2	138.3	2.526	62.6	54.8
5	78.3	50.0	2.340	33.5	21.4
6	21.9	294.0	2.518	8.7	116.8
7	16.7	106.9	2.675	6.2	40.0
8	13.9	63.7	2.523	5.5	25.2
9	22.0	44.3	2.750	8.0	16.1

* At Dry Reference ($25^{o}C$, 1 Atmosphere)

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TABLE 43

CANADA CEMENT LAFARGE - 1983

KILN STACK DIOXIN AND FURAN EMISSION RATES

Test Number	Stack Gas Flowrate* m^3/s	Emission Rates	
		Dioxins µg/s	Furans µg/s
1	29.8	0.57	3.13
2	28.7	0.09	0.92
3	28.4	0.11	0.12
4	29.0	1.82	1.59
5	27.4	0.92	0.59
6	27.8	0.24	3.25
7	31.3	0.19	1.25
8	30.0	0.17	0.76
9	32.1	0.26	0.52

* At Dry Reference ($25^{o}C$, 1 Atmosphere)

TABLE 28

CANADA CEMENT LAFARGE - 1983

STACK GAS TRACE METAL EMISSION RATES

Location	Test Number	Trace Metal Emission Rate						
		Ba* mg/s	Cd mg/s	Ca mg/s	Cr mg/s	Cu mg/s	Pb mg/s	Zn mg/s
Kiln Stack	1	0.5	0.31	1209.5	11.2	45.6	9.2	206.1
	2	0.3	0.17	607.2	11.1	17.6	4.7	54.6
	3	0.3	0.18	592.2	12.6	21.0	8.3	50.3
	4	0.4	0.15	375.7	12.7	20.6	12.2	1.2
	5	0.3	0.14	274.0	14.4	19.7	33.2	6.6
	6	1.8	0.16	584.0	13.8	19.6	19.4	4.1
	7	1.7	0.13	582.0	14.6	16.9	20.7	3.4
	8	1.6	0.17	487.9	12.6	11.7	18.9	1.3
	9	1.5	0.13	427.0	12.5	13.6	18.3	1.0
Cooler Stack	1	0.5	0.04	403.2	4.7	4.0	2.4	168.9
	2	0.5	0.02	446.6	2.5	2.4	3.6	14.6
	3	0.7	0.02	656.2	2.4	2.2	1.8	3.0
	4	1.0	0.04	1494.8	2.8	2.4	1.5	1.8
	5	10.8	0.03	3341.5	7.7	3.7	4.9	4.3
	6	0.3	0.03	545.6	2.1	3.7	1.2	0.7
	7	14.1	0.05	6990.6	12.6	5.2	7.1	6.5
	8	0.2	0.05	270.2	2.1	2.1	0.7	0.3
	9	0.3	0.03	360.0	2.1	2.1	0.7	0.3

* Suspect Because of High Filter Background Concentrations.

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TABLE 93

CANADA CEMENT LAFARGE - 1983

AVERAGE KILN STACK CONTAMINANT EMISSION RATES

Contaminant	Emission Rate Units	Contaminant Emission Rate		
		Baseline	20% Liquid Fuel	40% Liquid Fuel
Particulate	g/s	4.64	2.51	1.89
Chlorides*	g/s	0.70	1.31	2.92
Chlorine	g/s	<0.51	<0.42	<0.46
Barium	mg/s	0.37	0.83	1.60
Cadmium	mg/s	0.22	0.15	0.14
Calcium	mg/s	803	411	499
Chromium	mg/s	11.6	13.6	13.2
Copper	mg/s	28.1	20.0	14.1
Lead	mg/s	7.4	21.6	19.3
Zinc	mg/s	103.7	4.0	1.9
Total Hydrocarbon**	mg/s	362	662	764
Sulfur Dioxide	g/s	51.0	24.0	40.3
Nitrogen Oxides ***	g/s	40.3	26.0	24.7
Dioxins	µg/s	0.26	0.99	0.21
Furans	µg/s	1.39	1.31	0.84

* As Hydrogen Chloride (HCl)
** As Methane (CH_4)
*** As Nitrogen Dioxide (NO_2)

ORF

TABLE 95

CANADA CEMENT LAFARGE - 1983

AVERAGE COOLER STACK CONTAMINANT EMISSION RATES*

Contaminant	Concentration Units	Contaminant Emission Rate		
		Baseline	20% Liquid Fuel	40% Liquid Fuel
Particulate	g/s	1.06	1.27	0.89
Barium	mg/s	0.06	0.03	0.03
Cadmium	mg/s	0.03	0.03	0.04
Calcium	mg/s	502.0	545.6	315.1
Chromium	mg/s	3.2	2.1	2.1
Copper	mg/s	2.9	3.7	2.1
Lead	mg/s	2.6	1.2	0.7
Zinc	mg/s	62.2	0.7	0.3

* Excluding Tests in which Dust Collector Bypass Occurred (Test No.4, Test No.5 and Test No.7)

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TABLE 105

CANADA CEMENT LAFARGE - 1983

COMPARISON OF CALCULATED AND REGULATED IMPINGEMENT CONCENTRATIONS

Contaminant	Test No.	Maximum Emission Rate*	Calculated Impingement Concentration (a)	Regulated Impingement Concentration (b)	Ratio: (a),% (b)
(Base)	-	1.00 g/s	3.2 $\mu g/m^3$	-	-
Particulate Material	1	6.86 g/s	22.0 $\mu g/m^3$	100.0 $\mu g/m^3$	22.0
Hydrogen Chloride	7	3.23 g/s	10.3 $\mu g/m^3$	100.0 $\mu g/m^3$	10.3
Chlorine	3	0.50 g/s	1.6 $\mu g/m^3$	300.0 $\mu g/m^3$	0.53
Cadmium	1	0.31 mg/s	0.001 $\mu g/m^3$	5.0 $\mu g/m^3$	0.02
Chromium	7	14.6 mg/s	0.047 $\mu g/m^3$	30.0 $\mu g/m^3$	0.16
Copper	1	45.6 mg/s	0.15 $\mu g/m^3$	100.0 $\mu g/m^3$	0.15
Lead	5	33.2 mg/s	0.11 $\mu g/m^3$	10.0 $\mu g/m^3$	1.10
Zinc	1	206.1 mg/s	0.66 $\mu g/m^3$	100.0 $\mu g/m^3$	0.66
Sulfur Dioxide	1	58.1 mg/s	186 $\mu g/m^3$	830 $\mu g/m^3$	22.4
Nitrogen Dioxide	2	47.2 mg/s	151 $\mu g/m^3$	500 $\mu g/m^3$	30.2
Dioxins	5	1.82 µg/s	5.8 pg/m^3	450 pg/m^3**	1.29
Furans	6	3.25 µg/s	10.4 pg/m^3	22,500 pg/m^3**	0.05

* Kiln Stack Only
** Provisional Guideline

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TABLE 96

CANADA CEMENT LAFARGE - 1983

ONTARIO DRINKING WATER QUALITY CRITERIA

Compound	MOE Hazardous Waste Number	Maximum Concentration mg/L
Organics		
Aldrin/Dieldrin	S003	0.0007
Chlordane	S009	0.007
DDT	S012	0.03
Endrin	S014	0.0002
Heptachlor/Heptachlor Epoxide	S016	0.003
Lindane	S018	0.004
Methoxychlor	S020	0.1
Toxaphene	S029	0.005
PCB's	S025	0.003
Diazinon	S013	0.014
Methyl Parathion	S021	0.007
Parathion	S026	0.035
2,4-D	S002	0.1
2,4,5-TP	S001	0.01
Carbaryl	S008	0.07
Nitrilotriacetic Acid	S023	0.05
Trihalomethanes	S030	0.35
Inorganics		
Cyanide (Free)	S011	0.2
Fluoride	S015	2.4
Nitrate and Nitrite	S022	10.0
Nitrite	S024	1.0
Metals		
Arsenic	S004	0.05
Barium	S005	1.0
Boron	S006	5.0
Cadmium	S007	0.005
Chromium	S010	0.05
Lead	S017	0.05
Mercury	S019	0.001
Selenium	S027	0.01
Silver	S028	0.05
Uranium	S031	0.02

TABLE 68

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - ORGANIC ANALYSES FOR BASELINE TESTS

Compound	Leachate Concentration µg/ℓ							Detection Limit
	Kiln Waste Dust				Clinker Cooler Dust			
	Test 1	Test 2	Test 2	Test 3	Test 1	Test 2	Test 3	
Organochlorines								
Aldrin	ND	ND	ND	ND	ND	ND	ND	0.01
Dieldrin	0.01	0.02	0.05	0.02	0.04	0.02	0.02	0.01
α-Chlordane	ND	ND	ND	ND	0.02	ND	ND	0.01
γ-Chlordane	ND	ND	ND	ND	ND	ND	ND	0.01
Oxy-Chlordane	ND	ND	ND	ND	ND	ND	ND	0.02
DDT	ND	ND	ND	ND	ND	ND	ND	0.01
Endrin	ND	ND	ND	ND	ND	ND	ND	0.01
Heptachlor	ND	ND	ND	ND	ND	ND	ND	0.01
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	0.01
Lindane	ND	ND	ND	ND	ND	ND	ND	0.01
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	0.03
Toxaphene	ND	ND	ND	ND	ND	ND	ND	0.20
Aroclor 1254	0.16	0.17	0.48	0.23	0.42	0.21	0.22	0.07
Organophosphates								
Diazinon	ND	ND	ND	ND	ND	ND	ND	0.20
Methylparathion	ND	ND	ND	ND	ND	ND	ND	0.30
Parathion	ND	ND	ND	ND	ND	ND	ND	0.20
Phenoxy Acids								
2,4-D	ND	ND	ND	ND	ND	ND	ND	3.00
2,4,5-TP	ND	ND	ND	ND	ND	ND	ND	6.00
Carbamates								
Carbaryl	ND	ND	ND	ND	ND	ND	ND	0.50
Sequestering Agent								
Nitrilotriacetic Acid	ND	ND	ND	ND	1.2	ND	ND	0.50
Organohalides								
Trihalomethane	ND	ND	ND	ND	ND	ND	ND	4.00

ND = None Detected.

TABLE 70

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - ORGANIC ANALYSES FOR 20% LIQUID FUEL TESTS

Compound	Leachate Concentration, µg/ℓ						Detection Limit
	Kiln Waste Dust			Clinker Cooler Dust			
	Test 4	Test 5	Test 6	Test 4	Test 5	Test 6	
Organochlorines							
Aldrin	ND	0.09	ND	ND	ND	ND	0.01
Dieldrin	ND	ND	ND	ND	ND	ND	0.01
α- Chlordane	ND	ND	ND	ND	ND	ND	0.01
γ- Chlordane	ND	ND	ND	ND	ND	ND	0.01
Oxy-Chlordane	ND	ND	ND	ND	ND	ND	0.02
DDT	ND	ND	ND	ND	ND	ND	0.01
Endrin	ND	ND	ND	ND	ND	ND	0.01
Heptachlor	ND	ND	ND	ND	ND	ND	0.01
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	0.01
Lindane	ND	ND	ND	ND	ND	ND	0.01
Methoxychlor	ND	ND	ND	ND	ND	ND	0.03
Toxaphene	ND	ND	ND	ND	ND	ND	0.20
Aroclor 1254	0.62	0.54	0.41	ND	0.27	ND	0.07
Organophosphates							
Diazinon	ND	ND	ND	ND	ND	ND	0.20
Methylparathion	ND	ND	ND	ND	ND	ND	0.30
Parathion	ND	ND	ND	ND	ND	ND	0.20
Phenoxy Acids							
2,4-D	ND	ND	ND	ND	ND	ND	3.00
2,4,5-TP	ND	ND	ND	ND	ND	ND	6.00
Carbamates							
Carbaryl	ND	ND	ND	ND	ND	ND	0.50
Sequestering Agent							
Nitrilotriacetic Acid	ND	ND	ND	ND	ND	ND	0.50
Organohalides							
Trihalomethane	ND	ND	ND	ND	ND	ND	4.00

ND = None Detected

TABLE 72

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - ORGANIC ANALYSES FOR 40% LIQUID FUEL TESTS

Compound	Leachate Concentration µg/ℓ							Detection Limit
	Kiln Waste Dust			Clinker Cooler Dust				
	Test 7	Test 8	Test 9	Test 7	Test 8	Test 8	Test 9	
Organochlorines								
Aldrin	ND	0.11	ND	ND	ND	ND	ND	0.01
Dieldrin	ND	ND	ND	ND	ND	ND	ND	0.01
α-Chlordane	0.02	0.02	0.01	ND	0.02	0.02	ND	0.01
γ-Chlordane	ND	ND	ND	ND	ND	ND	ND	0.01
Oxy-Chlordane	ND	ND	ND	ND	ND	ND	ND	0.02
DDT	ND	ND	ND	ND	ND	ND	ND	0.01
Endrin	ND	ND	ND	ND	ND	ND	ND	0.01
Heptachlor	ND	ND	ND	ND	ND	ND	ND	0.01
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	0.01
Lindane	ND	ND	ND	ND	ND	ND	ND	0.01
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	0.03
Toxaphene	ND	ND	ND	ND	ND	ND	ND	0.20
Aroclor 1254	0.49	0.51	0.46	ND	0.20	0.19	ND	0.07
Organophosphates								
Diazinon	ND	ND	ND	ND	ND	ND	ND	0.20
Methylparathion	ND	ND	ND	ND	ND	ND	ND	0.30
Parathion	ND	ND	ND	ND	ND	ND	ND	0.20
Phenoxy Acids								
2,4-D	ND	ND	ND	ND	ND	ND	ND	3.00
2,4,5-TP	ND	ND	ND	ND	ND	ND	ND	6.00
Carbamates								
Carbaryl	ND	ND	ND	ND	ND	ND	ND	0.50
Sequestering Agent								
Nitrilotriacetic Acid	ND	ND	ND	ND	ND	ND	ND	0.50
Organohalides								
Trihalomethane	ND	ND	ND	ND	ND	ND	ND	4.00

ND = None Detected.

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TABLE 67

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - INORGANIC ANALYSES FOR BASELINE TESTS

Contaminant	Leachate Concentration mg/ℓ							Detection Limit
	Kiln Waste Dust				Clinker Cooler Dust			
	Test 1	Test 2	Test 2	Test 3	Test 1	Test 2	Test 3	
Free Cyanide	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fluoride	6.7	5.3	5.2	4.8	0.2	0.2	0.3	0.1
Nitrate	ND	ND	ND	ND	ND	ND	ND	0.1
Nitrite	ND	ND	ND	ND	ND	ND	ND	0.005
Arsenic	0.001	0.001	ND	ND	ND	ND	ND	0.001
Barium	0.55	0.63	0.57	0.67	0.81	0.89	0.86	0.01
Boron	0.06	0.02	0.02	0.03	0.01	ND	0.02	0.01
Cadmium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Chromium	0.03	0.03	0.02	0.04	0.06	0.11	0.04	0.02
Lead	0.40	0.10	0.08	0.42	0.12	0.11	0.10	0.02
Mercury	ND	0.0001	0.0001	ND	ND	ND	ND	0.0001
Selenium	0.025	0.055	0.063	0.042	ND	ND	ND	0.003
Silver	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uranium	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

ND = None Detected.

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TABLE 69

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - INORGANIC ANALYSES FOR 20% LIQUID FUEL TESTS

Contaminant	Leachate Concentration, mg/ℓ						Detection Limit
	Kiln Waste Dust			Clinker Cooler Dust			
	Test 4	Test 5	Test 6	Test 4	Test 5	Test 6	
Free Cyanide	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fluoride	11.4	14.6	12.8	0.5	0.6	0.5	0.1
Nitrate	ND	ND	ND	ND	ND	ND	0.1
Nitrite	ND	ND	ND	ND	ND	ND	0.005
Arsenic	ND	0.002	0.004	ND	ND	ND	0.001
Barium	0.38	0.18	0.18	3.0	2.6	1.4	0.01
Boron	0.11	0.19	0.23	ND	0.02	0.02	0.01
Cadmium	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Chromium	0.22	0.07	0.07	0.16	ND	2.00	0.02
Lead	0.13	0.35	0.09	0.08	0.07	0.07	0.02
Mercury	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
Selenium	0.04	0.11	0.43	ND	ND	ND	0.003
Silver	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uranium	0.01	0.01	0.01	0.01	0.01	0.01	0.01

ND = None Detected.

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TABLE 71

CANADA CEMENT LAFARGE - 1983

MOE LEACHATE EXTRACTION PROCEDURE - INORGANIC ANALYSES FOR 40% LIQUID FUEL TESTS

Contaminant	Leachate Concentration mg/ℓ							Detection Limit
	Kiln Waste Dust			Clinker Cooler Dust				
	Test 7	Test 8	Test 9	Test 7	Test 8	Test 8	Test 9	
Free Cyanide	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fluoride	15.5	15.5	15.0	0.5	0.5	0.5	0.5	0.1
Nitrate	ND	ND	ND	ND	ND	ND	ND	0.1
Nitrite	ND	ND	ND	ND	ND	ND	ND	0.005
Arsenic	0.001	ND	0.005	ND	ND	ND	ND	0.001
Barium	0.16	0.22	0.23	1.9	1.8	1.9	1.5	0.01
Boron	0.23	0.15	0.21	0.01	0.01	0.01	0.01	0.01
Cadmium	0.84	0.97	ND	ND	ND	ND	ND	0.005
Chromium	0.05	0.04	0.05	0.16	0.12	0.11	0.10	0.02
Lead	1.8	1.6	0.10	0.10	0.07	0.08	0.09	0.02
Mercury	0.0002	0.0003	0.0001	ND	0.0001	0.0001	ND	0.0001
Selenium	0.01	0.09	0.07	ND	ND	ND	ND	0.003
Silver	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uranium	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

ND = None Detected.

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STREAMLINING THE ENVIRONMENTAL ASSESSMENT PROCESS

by
W. Scott, Assistant Director, Environmental Assessment Branch, Ontario Ministry of the Environment, Toronto, Ontario

Introductory Remarks

Today I have no announcements of new programs, major studies, expert opinions or new directions. Instead I am here to bring you up to date on what our Branch has done and is doing to streamline the nuts and bolts part of Ontario's Environmental Assessment process.

Fitting enough for today, I come before you as a recycled pollution (not polluted) engineer. I do not have a lot of experience in the production of planning documents but I have experience at getting things done so I understand the importance of time and money.

What is the Environmental Assessment Process?

The Environmental Assessment Act is - in spite of rumours you may have heard - a very simple piece of legislation. A copy costs $1.50 as opposed to $3.00 for the Environmental Protection Act.

Part I (3 pages) - provides details on interpretation and the Act's application.

Part II (9 pages) provides details on what must be contained in an environmental assessment and explains the various steps that must be covered before the approval is given. Of the nine pages only one lists the required contents of the EA. The other eight set out the requirements for how the various steps in the approval process are to be carried out.

Part III (4 pages) sets out the power and duties of the Environmental Assessment Board.

Part IV (1 1/2 pages) sets out the powers and responsibilities of the provincial officers.

Part V (5 pages) deals with various administrative matters.

Part VI (2 pages) sets out the details and authority for making regulations.

Here is a brief description of the environmental assessment process as it has evolved from the legislation:

1. The proponent commences discussions with government representatives and interested public to obtain input on their cares and suggestions on anticipated problems.

2. The proponent prepares and submits an Environmental Assessment.

3. The Government Agencies review it and provide their opinion of the environmental assessment and the proposed undertaking in a single document called the government review.

4. The Minister publishes a notice that the Government Review is complete and that the Environmental Assessment and Government Review are available for interested people to review and comment on if they wish.

5. At the end of the public review period (usually 30 days) the Minister considers the environmental assessment, the government review and any submissions and determines whether to approve the undertaking - (with or without conditions) - whether to have it amended - or whether to refer it to a hearing.

6. The matter is approved after any identified problems are resolved.

Of course there are other possibilities but based on the experience since the EA Act came into effect, October 1976, this is the normal route. Occasionally it is not possible to resolve a difficulty and the matter is referred for a hearing. Of the 53 Environmental Assessments approved to date, only eight went to a hearing. I think you will gain some insight into the effectiveness of Environmental Assessments to date when you hear that these were the eight hearings:

1) Sault Ste. Marie Central Creek
2) Orillia Light and Power
3) Highway #89
4) Colonel Sam Bois Smith Park
5) South West Hydro
6) Eastern Ontario Hydro
7) Victoria Hospital EFW
8) Thunder Bay Auditorium

As you can see, there is not much that can be done to simplify that process without a change in the legislation.

Let me assure you however that there has been recent significant streamlining of the administrative processes.

The main areas of streamlining which I will discuss today are:

1. The development and implementation of Class Environmental Assessment documents,

2. Clarification of the task which each member of the government review team is to carry out during the review of the environmental assessment against the reviewer's mandate,

3. Development of a formal consultation process to ensure the proponent has input from the various "concerned" agencies at the beginning of the planning process,

4. Development of a joint notice to satisfy the Act's requirement for a Notice of Acceptance (Section 9) and a Notice of Approval (Section 13(3)).

5. Hearings held before the Joint Board.

6. Mediation.

7. Proposing to revise definitions of Waste Management to use the EA Act only for activities significant enough to warrent the attention.

8. And lastly, (in the area of waste management activities) marrying the requirements of the EA Act with those of the Area Waste Management Master Planning process to allow both to proceed as a single project eligible for some MOE financial support.

Today, before I address our progress in **streamlining Waste Environmental Assessments,** I would like to spend a few moments on the other areas.

1. Streamlining through Class Environmental Assessments

The Act applies to all undertakings of the Province, public bodies and municipalities. Since "undertaking" includes programs as well as specific enterprises, there are an enormous number of environmental assessments required. Out of recognition that some groups of undertakings have important characteristics in common, have a generally predictable range of effects, and are unlikely to cause significant environmental effects, the Class Environmental Assessment approach was developed.

In a class document, a proponent submits a document to seek approval for a type of project or activity which will be carried out (in the fashion set out in the document) at a time and place to be decided by the proponent.

Once the class document has been approved, the proponent follows the procedure set out in the EA when handling future undertakings. Some examples of recent class EAs are:

1) Municipal Water and Sewage Works
2) Municipal Roads Projects
3) Ministry of Natural Resources Solid Waste Disposal Unorganized Areas

I should mention that the Class EAs include a screening process which identifies projects which are significant enough to warrant being **"bumped-up"** to being required to conduct an individual environmental assessment.

The use of Class Environmental Assessments has greatly reduced the number of undertakings for which proponents must submit an individual environmental assessment.

2. Streamlining through Clarification of the Role of Government Reviewers and Tightening of the Review Schedule

Representatives of government agencies now review environmental assessments only from their respective mandate. Comments supplied by reviewers are authorized by the senior level of the Ministry or agency. This has greatly simplified things for proponents because reviewers have the expertise and authority to find ways of overcoming perceived problems.

At the same time as the clarification of reviewers' roles, there has been a tightening up of the project handling to ensure the review comments are submitted within the scheduled time. For most EAs the review team submit their individual comments within 45 days. This has enhanced program delivery.

3. Streamlining through Early Guidance and Input to Proponents

The Environmental Assessment Branch has produced Guidelines for Presubmission Consultation to help proponents obtain guidance and timely information from the public and government agencies which have possible concerns related to the undertaking. We have found that early dialogue greatly reduces the frequency and seriousness of problems identified during the formal review of the environmental assessment. Dialogue at the earliest stages permits a proponent to focus on major issues at a time when decisions are still reversible and resource commitments are still flexible. As one mining man put it - you can then solve the problems with a pencil rather than a bulldozer.

During the early discussions, the Branch can share with a proponent the knowledge gained from experience that other proponents have had with earlier environmental assessments and hearings. This ensures every proponent need not "re-invent the wheel" with each EA.

To assist proponents in the preparation of their EA, many members of the review team have prepared guidelines on how the specific matters within their mandates should be approached. Although every EA is unique making a check list of limited use, the guidelines go a long way to help proponent get a good start.

We have observed that the quality of EAs has improved when consultation was carried out early in the process.

4. Streamlining Through Joint Notices

In instances where there are no formal requests for a hearing and where the concerns of the government review team and the public are covered off by conditions which are satisfactory to all parties, we now prepare a combined Notice of Acceptance and Approval to satisfy the requirements of Sections 9 and 14(3) of the EA Act. This reduces the cost and time necessary for the giving of notices. Previously there was a 15-day period after the Notice of Acceptance was issued (to the proponent and to any person who has made written submissions) before the Notice of Approval would be processed. The use of combined notice removes approximately one month from the purely administrative component of the EA review process.

5. Hearings Before the Joint Board

While we can take no credit for developing the Consolidated Hearings Act, the advent of the Joint Board Hearing has greatly simplified the overall approval process for proponents. Now virtually all issues in dispute can be addressed at one hearing. Currently the two of the Environmental Assessments which have been referred for hearing are scheduled for Joint Board Hearings.

While Joint Board hearings streamline the total approval process, they do not provide a significant decrease in time or the process associated with the EA component when considered on its own.

6. Mediation

At this time the Environmental Assessment Board has arranged to have a mediator assist in the North Simcoe landfill search as a pilot project. As you are probably aware, there is considerable interest in the process of locating a waste disposal site to replace the well known Pauzi site. The mediator was appointed to facilitate the hearing process under the Environmental Protection Act. As the Board gains experience from this trial, it will determine the applicability of this technique as a formal component of the hearing process.

As I indicated a few moments ago, the EA Branch has encouraged and emphasized **early** and **open** dialogue between the proponent and those parties with a direct interest in the problem and/or the solution. This dialogue encourages identification of differing view points and permits determination of compromises and solutions. During such discussions, EA Branch staff may function as a mediator in the event of any interruption of the communication.

Other than our unofficial mediation during pre-submission discussions, we anticipate mediation will have its greatest impact on those few environmental assessments which must go to a hearing.

7. Proposal of Blueprint - Revise Definitions so only Significant Waste Management Activities are Subjected to the EA Act

Presently waste facilities are subject to approval under the Environmental Protection and Environmental Assessment Acts. New waste facilities serving more than 1,500 persons or revisions to such sites are subject to mandatory hearings under present EPA legislation.

Out of recognition that the evaluation process under the EPA adequately provides for public input and protection of the natural environment for small waste sites, the Ministry suggested through the Blueprint that waste disposal sites with a design life of under 100,000 tons be subject to only the EPA approval process. This proposal has received widespread support from municipalities and others.

We are not certain whether the Blueprint proposal will be adopted as is, but indications are that the concept, in some form, will likely be included in the process that comes out of the Blueprint exercise.

8. Streamlining Waste Environmental Assessments by Marrying the EA and Area Waste Master Planning Process

Last year at this conference the Honourable Keith Norton, then Minister of the Environment, announced the Ministry's **BLUEPRINT FOR WASTE MANAGEMENT: THE CHALLENGE FOR ONTARIO IN THE 1980's**

It is probably worthwhile review the presentation made at last year's conference to set the tone for this part of my presentation. Under the heading entitled planning, the Minister said,

> "Waste management begins with planning and this is an area where the temptation is greatest for some municipalities to take short cuts in the interests of expediency.
>
> There are several municipalities which assume a degree of responsibility for all wastes produced in their jurisdiction, and for long-term area waste management planning to cope with these wastes. However, this is not the case with all municipalities -- but I intend to ensure that it will be.
>
> Municipalities must strive for a better quality in waste management planning, incorporating more constructive public consultation to reduce the atmosphere of conflict which prevails in so many waste site decisions to date.
>
> I regard the issue of Municipal planning as a critical area of the Blueprint."

The Minister has already brought you up to date on the current status of the Blueprint in his presentation Monday. I intend to concentrate on the two components of the Blueprint which are directly related to the topic which Nars Borodczak selected for me to give. These are:

1. Area Waste Management Master Planning
2. Hearings, Approvals and Appeals

Area Waste Management Master Planning

I believe there are none here who would disagree that the success of any activity is very much influenced by the planning/preparation carried out beforehand. "An ounce of prevention is worth a pound of cure."

These days proponents who approach the whole issue of waste management on a piece-by-piece basis are experiencing major setbacks.

Through the area waste management master planning process, the Province has encouraged the development of a strategy/approach setting out how the wastes within a greater geographic area will be handled over a twenty (20) year period. The Ministry of the Environment has provided subsidies of 50% of the costs of the studies as long as more than one municipality or a restructured municipality was involved.

As the process of phasing in the application of the Environmental Assessment Act to municipal waste disposal undertakings proceeded, concern was expressed that proponents would have to go through very similar type processes to produce the required Environmental Assessment and an Area Waste Management Master Plan. The Blueprint indicated that the approval requirements for establishing waste facilities under Part 5 of the Environmental Protection Act would parallel the requirements of the Environmental Assessment Act.

Now, the Guidelines for the Preparation of Waste Management Master Plans are much broader in scope, covering programs for all aspects of waste. Area Waste Master Plan projects receiving 50% MOE funding now produce the Master Plan and also the majority of the documentation

appropriate for submission of the Environmental Assessment. To qualify for the provincial funding the plan must be prepared in accordance with the Guidelines for the Preparation of Waste Management Master Plans prepared by the Waste Management Branch in consultation with our Environmental Assessment Branch.

I must emphasize that the master planning process does not usually produce a full EA. The plans produced to date have been general in nature usually not selecting specific technologies or specific sites. Such plans might include statements such as "an energy from waste facility to be located in the north east corner of the municipality". The Regional Municipality of Waterloo is going a step further. The Region has gone beyond the normal master plan and is in the early stages of including specific details on technology and site locations. The final document will be submitted as a complete EA to obtain a single approval for all works covered by the waste master plan.

The waste management master plan usually consists of three components:

1) Description of the Waste Management Activities to be established over the life of the plan defined in enough detail so those affected can determine whether they wish to provide input into the process.

2) Description of the planning process which will be used to handle new alternatives and effects upon the environment which cannot be specifically described when the plan was developed. These planning procedures allow for evaluation of specific alternatives and effects when components of the plan are proposed for implementation.

3) A mechanism to allow the plan to be updated.

The similarity between the components of the master plan and the first two components of required contents of an EA document is apparent. The required contents of the EA (our "well-known" Section 5.3) are:

(a) - Description of the purpose

(b) - Description and Statement of Rationale for
  (i) the undertaking
  (ii) alternative methods of carrying out the undertaking
  (iii) alternatives to the undertaking

(c) - Description of
  (i) the environment that will be affected
  (ii) the effects caused to the environment
  (iii) the actions to mitigate effects upon the environment

(d) - Evaluation of the advantages and disadvantages to the environment of the undertaking, the alternative methods of carrying out the undertaking and alternatives to the undertaking.

Master planning is now a comprehensive process which allows consideration of the major contentious issues to be dealt with in a single planning, government review and when necessary, hearing forum. Planning can be carried out and EA Act approval received without having to develop the expensive detailed engineering information necessary for approval of the component activities.

Perhaps a "for instance" would help here.

A regional municipality's waste management master planning process having:

existing waste management facilities
- inventory of facilities and transportation networks
- assessment of potential environmental, economic and public impact
- evaluation of useful life of and possible future uses of existing facilities

developed an inventory of waste generation in study area,
- including present situation and best guess projections

- evaluated system options in terms of costs and potential environmental impacts and determined how such impacts may be mitigated,

- prepared a detailed development schedule setting out dates for all of the key milestones of each facility set out in the master plan,

- detailed on updating mechanism for the plan,

would allow completion of an Environmental Assessment for its undertaking of waste handling for the next 20 years. Once approval had been obtained the municipality could go about investigating, designing and obtaining technical approval for the hard facilities as specified in the planning document. As the detailed plans were set forward, the question of need, consideration of other alternatives will have already been addressed so the matter under review will be restricted to the technical details of only the specific site under review.

Concluding Remarks

We believe the eight mechanisms just discussed have streamlined the administrative process and improved the EA process by providing better and earlier guidance to proponents and by speeding up the formal processing of EAs. We are committed to further improvements.

THE DEVELOPMENT OF WASTE MANAGEMENT AND SOLIDIFICATION FACILITIES IN QUEBEC

by
G.A. Douglas, Regional Manager Ontario, Stablex Canada Incorporated, Willowdale, Ontario

I know a lot of you attending today have participated during the past few years in more than a few seminars, work-shops and conferences dealing with the subject of industrial waste.

We seem to spend an awful lot of time articulating the problems and debating the issues. Do you ever get the feeling, though, that despite all the talk nobody appears to be really doing anything constructive about the problem of industrial waste?

If that thought concerns you, then I have a rare treat for you this afternoon -

I just happen to have with me some pictures of a world class state of the art hazardous waste treatment plant that was recently built right here in Canada.

The Stablex Industrial Waste Treatment Centre at Blainville, Quebec is the first of several plants the company will build to serve North American industry. It was completed "on schedule" and "within budget" and commenced operations during the spring of last year.

The Blainville facility was completed at a cost of slightly over 20 million dollars. It has the capacity to treat 70,000 tonnes of industrial waste annually (on a one shift basis), utilizing the Sealosafe fixation/solidification technology, which converts hazardous inorganics to a safe and useful product called Stablex.

Unlike most solidification processes, the Sealosafe technology employs extensive physical/chemical pre-treatment prior to final solidification.

The process makes provision for cyanide destruction, chrome reduction and many other pre-treatment processes.

The plant I am going to show you accepts liquids, solids and sludges, in bulk or in drums.

By way of perspective, the Stablex plant at Blainville provides the solution to approximately 60% of Quebec's hazardous industrial waste problem.

The building on the right houses the laboratories and some offices. The entire treatment operation is performed in the plant on the left.

As you can see, all of the storage and operating facilities are covered-in. No tanks, drums or process equipment are visible from outside the plant.

No wastes will be accepted in this plant until the Stablex Lab has analyzed a typical sample of the waste in question and confirmed that the Sealosafe process can treat it effectively. Only then will a shipment of the waste be scheduled to the plant.

When each shipment arrives at the plant, a sample for the truck will be analyzed to determine whether or not the load conforms to the original pre-shipment sample.

Subject to this confirmation, the truck can unload.

An in-plant dust gathering system collects airborn solids and returns them to a hopper in the solidification tower, where they are converted to Stablex.

Unloading, storage, pre-treatment and solidification are accomplished through an automated central control panel.

All storage and reaction vessels are covered and vented to segregated fume gathering systems which return their contents to the treatment process. Consequently, there are no gaseous emissions from the plant.

There is also no liquid effluent from this plant. All wastes entering the plant, even the rain water falling on the working areas of the plant, are eventually converted to Stablex.

The only thing that leaves this plant is the final Stablex product, which is placed in a secure product placement site located on provincial government-owned land immediately adjacent to the Treatment Centre.

The plant you have just seen represents the leading edge of proven technology for the safe treatment of inorganic industrial wastes. We know of no other plant in the world that processes inorganic wastes to the extent that they are treated by the Sealosafe process in Blainville.

The siting of the Stablex waste treatment centre at Blainville represents a unique example of co-operation between three levels of government, the local citizens and the Stablex organization.

It may be interesting at this time to reflect on some of the ingredients that are essential to the success of such a difficult project.

First of all, I believe you need a proven technology, and a proponent with the operating experience and know-how that are necessary in order to apply the technology.

You will obviously require a suitable site.

Next, I believe it is essential that you have at least a threshold of support from the local community. Stablex was very fortunate in Blainville in this respect. When preliminary hydrogeological and other studies identified Blainville as one of the best candidate areas for such a plant, the mayor and council voted unanimously to invite Stablex to build in their community. They supported the project through public participation and public hearings, despite significant opposition by some of the citizens.

I believe it is noteworthy (and I hope it may provide inspiration for some municipal politicians) that the mayor and council were rewarded for their courage and foresight - they were re-elected by acclamation shortly after the project was approved by the Quebec cabinet.

That brings me to the final ingredient in the recipe for success -

There must be a need for the level of treatment services that the plant is designed to provide.

While some jurisdictions may covet the level of treatment you have just witnessed and while there is a generally perceived need by the population at large for the highest levels of waste treatment available, it is actually government legislation and municipal by-laws that create the need for services and define the exact level of treatment that will be required.

If the environmental regulations permit the use of "low-tech", "low-cost" options, a plant like the one you have just seen cannot compete.

Any waste management company, private or public, that invests in a plant based on technology that exceeds the level of treatment that the law requires, is courting disaster.

It should also be noted that the current availability of low-cost options that are within the law creates a serious disincentive for generators to abate, recover, recycle or properly treat wastes in-house.

It takes a very brave waste generator to pay a premium for recovery, recycling or a high level of treatment, while his competitors are sending their wastes to landfill, with at best a bare minimum of treatment.

It is our opinion that most responsible waste generators would welcome higher levels of waste treatment. Many of them are already very concerned about the long-term liabilities associated with waste disposal. Recent legal concepts of "cradle to grave" liability suggest that generators should utilize the finest waste treatment technology available in order to indemnify themselves from future financial disasters. However, as long as there are tempting low-cost options available under law, the good corporate citizen who pays for the best treatment, will be very vulnerable to less responsible competitors.

We commend the Ontario Ministry of the Environment for their intention to enact new waste management legislation. We are impressed by the thoroughness of their approach to the subject.

We strongly urge the ministry to bring in legislation and write regulations that will raise the existing levels of treatment to the point where they are consistent with the best available technologies in the world. Otherwise, those waste management companies who strive for excellence must direct their resources elsewhere, and Ontario could indeed become a low-cost dumping-ground for wastes from other jurisdictions.

The environmental axiom with which I have chosen to conclude my remarks, is a simple one -

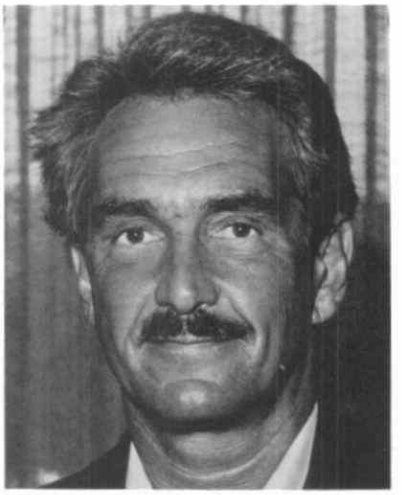
"World-class environmental protection requires world-class technology and treatment facilities which are entirely dependent on world-class legislation".

SESSION V – CHEMICAL WASTE AND WATER SUPPLY

Chairman: W.M. Vrooman,
Director, Northwestern Region,
Ontario Ministry of the Environment,
Thunder Bay, Ontario

Dr. Neva Hilliard, Ontario Medical
Association, Toronto, Ontario

Dr. Jim Day, OMA
Toronto, Ontario



Dr. J. Lehr, Executive Director,
National Water Well Association, and
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Dr. W.L. Lappenbusch,
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Environmental Protection Agency,
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CHEMICAL CONTAMINANTS IN WATER - A MEDICAL PERSPECTIVE

by
Dr. J. Day and Dr. N.B. Hilliard, Ontario Medical Association, Toronto, Ontario

The Ontario Medical Association is concerned with all aspects of human health. Over the years physicians of this province, through the Ontario Medical Association, have accepted responsibility for assessing health effects of water contamination and advising appropriate agencies in respect to this. Previously, public health concerns have focused on sewage and waste disposal because of epidemic potentials inherent in municipal discharges. Since the mid 1960's these problems have become reasonably contained and are secondary to the much greater menace confronting human health now and in the future - chemical contamination of our water resources.

The Ontario Medical Association voiced alarm over widespread pollution of the Great Lakes in 1970 and demanded that responsible governments co-ordinate action to deal with it. The Public Health Committee of the Ontario Medical Association, in its report to Council, recommended that the Canadian Medical Association advise "the government of Canada enter into negotiations with the government of the United States to establish, with all possible speed, an international body with full regulatory power throughout the Great Lakes drainage basin". Thus, making the Ontario Medical Association one of the first groups to formally propose this process to deal with Great Lakes pollution. Since then the Ontario Medical Association, through its members, has actively dealt with a wide range of environmental issues including individual membership on the Science Advisory Board of the International Joint Commission and chairmanship of the Task Force on Health Effects of Non-phosphate Detergent Builders.

The medical community, then, through its association has clearly expressed a committment to the environment and immediate and future impact of contamination of possibly the most vital resource, second only to air we breathe - water.

MEDICAL DILEMMA

The patients with signs and symptoms of ill health go first to the family practitioner in the community. Often the problem will not be straight forward, but rather will present as a complex mix of symptoms including his or her own perception

of his or her medical state. The doctor, in dealing with this complex mix, uses clinical training and diagnostic tools available to him to determine the cause or causes and the varied interrelationships in establishing diagnosis and management. In certain instances, the cause of the condition is not readily accessible and the physician's medical training and technical skills are inadequate, thereby, precluding appropriate treatment. Such may be the situation when environmental contaminants are the basis of the problem.

The reason for this medical uncertainty is because of an increasing growth in the introduction of chemicals into our environment and limited available knowledge relative to health effects making proper assessment of each chemical difficult, and their combined effects, next to impossible to ascertain. Differences of scientific opinion regarding levels and manifestations of toxicity complicates the matter leaving the physician to rely on other than clinical experience because of the newness of the condition. Expressions of extreme opinions influence physician and community views on the matter. Public and professional opinion, often only conjecture, leave varying attitudes and perceptions of health impact, effectively polarizing opinions of either fear or complacency.

The patient, then, having symptoms relative to chemical contamination or, fearing that this is a cause, needs access to knowledgeable physicians whose information base is "state of the art" or at least informed as how to get such information and apply it. Presently, the physician deals with this complex relationship of environmental contaminants on health without the assistance of sufficient expertise in the diagnosis and the management of his patient which, in effect, is not accessible.

THE GROWTH OF UNCERTAINTIES

Since World War II the number of chemicals introduced annually into the environment is massive and is of great concern. It is estimated that two thousand chemicals are introduced annually and, of these, a large number are considered to be environmentally dangerous. Knowledge of their impact on the environment lags behind their introduction and although some have been subjected to animal studies, few have

been tested in humans. Judgements, then, invariably fall on response to animals or mutagenicity in bacteria leaving open the question of short or long-term effects on humans.

The problem is not just limited to toxicity of individual chemicals as they are introduced into water systems, rather the combined effects of these chemicals on those already present. Chemical interaction possibly creates a higher degree of toxicity, the impact of these on biological systems over time is hardly answerable.

Our need to project into the future is emphasized by accepted actions of yesterday which have become the problems of today as is exemplified by the calamity of Love Canal. In retrospect, this tragedy would have been prevented by available foresight, which would have led to appropriate legislation.

Each jurisdiction has responsibility not only to the immediate community but also to the global environment. Compounds released in one area may express its effects at a distance. A high standard of water pollution control in one area, whether it be a municipality, county, province, state or country, may be negated by the impact of contamination originating at a distant site. It is a requirement that water quality standards be accepted internationally and to prevent economic stresses from dictating these standards, in order to obtain a competitive edge in the marketplace. Otherwise, environmental standards are meaningless since secondary pollution would be inevitable.

This becomes a societal responsibility beginning with the understanding that what is produced has with it the side effects of waste which must be the responsibility of the communities involved.

FILLING THE VACUUM

The concern of chemical contamination of our water focuses on human well-being. The control and elimination of such contamination is primarily directed towards protecting human health and ensuring multiple uses of our aquatic resources without risk to health. The public today, although constantly reminded of pollution, is frequently desensitized to it preferring the problem to simply go away. At the same time

levels of awareness of toxics in the environment and the question as to the effects these are having on personal well-being are raised. Conditions not accounted for medically are now being laid at the doorstep of chemical contamination and the physician is being asked to help.

Unfortunately, the practicing physician, is on the whole, lacking in knowledge of the health effects of low levels of chemical exposure such as may be encountered in water. The public seeks answers. The medical vacuum, thus created, is being filled by an ever increasing number of physicians and laboratories who have developed their own interpretation of what is perceived by society as environmental health problems (20th Century Disease). Unanswerable questions leave the treating family physician and, indeed, other physicians in the community, off to the side since there is really no source of medically sound information on the subject. The result is that a self-proclaimed specialty has arisen like "Phoenix from the ashes" using unconventionally and medically unproven methods in the assessment and management of patients with environmentally related concerns. The physician, dependent on scientific principles for medical judgement and because of their lack of accessibility, are unable to meet the needs of the alarmed public.

FUTURE FOCUS

The growing uncertainty of the impact of chemical contamination of our water systems places a responsibility on the physicians to become involved in environmentally related clinical problems and environmental research. Physicians need more relevant knowledge of environmental health and the impact of contaminants on human health. If we are to live in this world, we must accept the responsibility of the consequences of our actions and modify them if we will. We must be aware of the impact of these chemical contaminants and their mode of presentation.

The urgency of this issue, since it is clearly in the arena of medical responsibility, places an obligation on the medical profession to develop organized relevant knowledge and expertise in the area of environmental health and develop and maintain professional requirements for formal recognition as expected of other established specialties in

medicine, in order to deal with the ever growing concerns over environmental health problems. These physicians should be a product of co-ordinated programs in established institutions bringing together occupational health, pharmacology and toxicology, immunology and behavioural neurobiology and should provide the necessary expertise and leadership to deal with perceived environmental problems. They would act as medical consultants on a one-to-one basis providing a crucial educational role to the physicians in the community at large, and advise private and public agencies at various levels. The means are at our disposal leaving only the will to close the gap in the knowledge of chemical toxicity to provide the basis for the development of future preventive measures and maintenance of health and well-being.

GROUND WATER - USED, ABUSED AND MISUNDERSTOOD
(BUT STILL OUR BRIGHTEST HOPE)

by
Dr. Jay H. Lehr, Executive Director, National Water Well Association, and Editor, Groundwater Journal, Worthington, Ohio

Ground water, once an ignored, underestimated and undeveloped national resource, is now the subject of media focus but almost always with negative emphasis. Stories abound of critical health hazards existing in our drinking waters in all industrialized areas while rapidly lowering water tables are said to threaten agricultural production in areas dependent on irrigation. The news about ground water never appears to be good. But how much ground water have we really polluted? And are we really running out of water? In the short time available today, I would like to examine these two areas and try to allay some of the myths surrounding them.

Let's start with water quality. I'm going to prove to you that less than 1% of the ground water in this country is contaminated.

Pollution Assumptions

First I'm going to make some assumptions. Let us assume that if we take all of the point sources of pollution--lumping together the septic tanks and the landfills, the pits, ponds and lagoons, and other such nefarious improperly designed waste disposal techniques--there are 200,000 sources of pollution that are oozing pollutants into the ground. That's a high number. EPA and the news media talk only in terms of 75,000 to 100,000 industrial sites, but I'm throwing in all other more innocuous point sources of pollution and calling it a nice round 200,000. Let's further assume that they each are creating a plume that is 1,000 feet wide and 100 feet thick. Let us assume that each plume moves about 4 inches per day or roughly 125 feet per year

(faster than most hydrogeologists would believe) and that they have been traveling for 40 years since their initial emplacement (a longer history than most). Forty years at 125 feet a year is 5,000 feet (which makes for a well rounded mile). Thus each of these 200,000 plumes has moved a mile from its source. Let us assume that they are polluting aquifers that are 25 percent porous.

Adding It Up

How much water have we polluted? 200,000 times width = 1,000 feet times thickness = 100 feet times length = 5,000 feet times porosity = .25. This equals 25,000,000,000,000 cubic feet. Converting cubic feet to gallons (7.5 gal/cu.ft., but rounding to 8 for grocery store simplicity) we arrive at 200,000,000,000,000 gallons--or 200 trillion gallons of polluted ground water!

Available Ground Water

How much water do we have? Any grocery store clerk can figure out how much ground water we have in the U.S. but few have done it. The area of the conterminous United States is 3,000,000 square miles. It computes easily because the U.S. is nearly rectangular, being 3,000 miles wide and about a thousand miles long. How much ground water is contained therein depends on how deep we are willing to drill. We'll make it simple and say a third of a mile (1,760 feet) is as deep as we will drill in the future. You may not want to drill a well a third of a mile deep, but what choice are you going to have 100 years from now? We didn't want to pay a buck and a half for a gallon of gas either. On the other hand, we will ignore all of the water below a third of a

mile, even though we recognize it represents 60 percent of the earth's ground water reserves. Now, how much ground water can we get out of the upper third of a mile of the earth's crust? That depends on its specific yield. (Quantity of water expressed as a percentage of the total rock volume that will drain out under the influence of gravity.) While it varies widely between the sedimentary, igneous and metamorphic rocks that make up the earth's crust, I will assume a national average of 10 percent which most hydrogeologists would agree is a conservative figure. Thus three million square miles in area times a third of a mile in depth is one million cubic miles of rock, times 10 percent specific yield, gives us 100,000 cubic miles of water. Remembering that our rounded mile has 5,000 feet, cubing 5,000 we get 125,000,000,000 cubic feet per cubic mile. Thus 100,000 cubic miles equal 12,500,000,000,000,000 cubic feet of ground water. Then converting to gallons at 8 gallons per cubic foot, we end up with 100,000,000,000,000,000--that is 100 quadrillion gallons of water. Thus we've got 2×10^{14} (200 trillion) gallons of polluted water. We've got 1×10^{17} (100 quadrillion) gallons of ground water available. Therefore, the percentage of ground water already polluted is $2 \times 10^{14} / 1 \times 10^{17}$ which equals .002, or two-tenths (.2) of 1 percent.

Assumptions Challenged

If you insist that the average plume is 1,500 feet wide, then we've polluted three-tenths (.3) percent. If you also want to say that it's 150 feet thick, then we've polluted .45 percent. If you believe the average plume has gone 1.5 miles instead of 1 mile, then

we've polluted .675 percent. If you insist, the specific yield is closer to 5 percent than 10, then we have polluted more than 1 percent and if you further want to decide that there are 300,000 of these plumes, then the pollution does reach 2 percent. But no matter how liberally or conservatively we slice it, we're dealing with a very small fraction of our ground water.

Alternate Calculations

Attempting the calculation from another direction, EPA estimates of known pollution sources leaking into the ground average about 1.5 trillion gallons per year. If we double that to account for unknown sources we get 3×10^{12} (three trillion) gallons leaking in every year. Let's say it's been leaking in for 33 1/3 years, then we have 1×10^{14} (100 trillion) gallons of polluted ground water which is only half as much as we calculated with our 200,000 sites. Similarly, if we used USGS estimates of ground-water availability (in the neighborhood of 200 quadrillion gallons) the percentage of polluted ground water drops even further.

Averages Don't Always Count

I believe I have been conservative on all my numbers. It is therefore reasonable to say we have not polluted even 1 percent of our ground-water system. Now the part you can argue with is that we have polluted the ground water unevenly and concentrated our misdeeds where our dependence on it is greatest. In the industrial sections of New York, New Jersey and New England, we have indeed polluted a lot more than 1 percent. They have very serious problems, but there is still a considerable amount of unpolluted ground water available in these areas as well.

Additionally, we will likely uncover many more yet unknown locations of severe ground water pollution, but one should not be led to a conclusion that they are ubiquitous, for they are not.

What Does It All Mean

My primary point is that we have yet to pollute 1 percent of our total water supply. We can eliminate the initiation of new sources within 10 years and create a public ethic and morality which will put an end to all such ill conceived practices. The existing plumes will not have moved much further or polluted much more. The odds are in our favor to end up with 98 percent of our ground water still unpolluted at the end of this century.

It's frequently going to cost us more to get because we may have to drill at greater distances from the point of use and to greater depths, but that is still a small price to pay for such a precious resource.

If we start work now we can stop polluting ground water; we can keep the percentage low. Additionally we can restore some aquifers, treat some of the water, reduce the movement of some hazardous plumes, though we may have to abandon other areas.

The Bottom Line

Finally, we have to tell this story to the public before they decide, "What a shame we didn't discover ground water before it was all polluted." Ten years ago the public didn't know there was such a thing as ground water. They only drilled a well on the judgment of the court of last resort.

It is in the best interest of the public to better understand the situation, specifically that ground-water pollution, while serious, is not quite the crisis some lead us to believe. We've got a problem and we want action; we want the press and the public to keep arguing for ground-water cleanup. But we don't need any Chicken Littles telling us that the sky is falling, because it most certainly is not.

Not Enough To Go Around?

Now that you are convinced that we will have water of adequate quality, let me address how we can also assure ourselves than an adequate quantity of water will be available for future use.

The media is forever focusing on areas of the United States where the wanton waste of water has for decades led to water shortages. In actuality no more than 15 percent of this nation suffers from a real water shortage. The bulk of that territory consists of the infamous Ogallala Aquifer. It also includes populous areas of Arizona and southern California. But the "American water crisis of the 80's," as some have called it, need not be present in even 15% of the nation. We do have a crisis, but water is not at the root of it. The crisis is one of poor management practices brought on by an abundance of stupidity and lack of planning.

Problem Defined

Let us look at practices which have led us to the path of wanton wastefulness. For years we have insisted that the desert be lush and green through irrigated agriculture. The crops were often unnecessary and more often unprofitable, but federal subsidies often encouraged the increased development which was tied to a finite resource. In

areas where water consumption was far exceeding the natural recharge, little was done to try to replenish that supply or to conserve in water use. Irrigation practices were perhaps the most wasteful of all. Water was typically sprayed into the air where the hot dry air took its toll through evaporation. What water fell to the ground was partially evaporated again while waiting for the crop to absorb the moisture--all this at an efficiency rating of less than 30%!

Where localized shortages began to occur, the overuse of ground water in certain geologic regimes caused the land surface to subside, resulting in serious damage to surface structures and irreversible damage to the aquifers. But were conservation measures implemented or were the pumps shut off before further subsidence occurred? In most places, the answer was no. The thirst for water overpowered the conservation of the resource or the protection of the structure that housed that resource.

But wastefulness did not end here. If the ground wouldn't yield enough water quickly enough, the answer was to build surface reservoirs or elaborate pipeline systems to transport the water. Never mind that surface reservoirs exposed the water to tremendous loss through evaporation and reduced the amount of available water even further. Never mind that the cost of transporting water in expensive pipelines often outweighs the profits at the end of the pipeline. Never mind that the source of water was often already overcommitted and another pipeline only shifted the problem to someone else. At all costs--water.

Resource Evaluated

Let's stop and see just how much water we have to work with and where the water is distributed.

The world's water supply is distributed such that most of the water resides in the oceans and the greater part of the remaining water occurs in icecaps and glaciers, leaving less than 1% of the world's water, regardless of state -- solid, liquid, or gas -- actually available to us. Of that small amount of water, over 98% is in the ground.

Fifty percent of the water in the ground is located in the upper one-half mile of the earth's crust; the other 50% is located in the next two miles of the crust. Over 95% of the ground water that we use comes from the upper 3,000 feet of the crust.

Throughout the world, 500,000 cubic kilometers of water move through the hydrologic cycle each year. The water comes largely from the oceans and to a lesser extent from the land. The same water that evaporates from the oceans and the land surface falls back as precipitation each year. The amount of water that falls back as precipitation is equal to the amount which is evaporated. Fortunately, there is a net gain of 40,000 cubic kilometers of water to the land each year -- this is about twice the amount of water stored in the Great Lakes.

However, while 40,000 cubic kilometers of water is more than ten times the amount of water we use each year, most of it is not available to us for capture and subsequent use. Twenty-six thousand cubic kilometers simply flows back to the sea, rivers, and streams or is held in the bank storage of those rivers and cannot be economically obtained. Another 5,000 cubic kilometers falls on more inaccessible areas where economic development is not likely -- areas such as the Amazon River Basin. Controllable waters in habitable areas measure only 9,000 cubic kilometers -- still more than three times the amount of water used each year.

Now, what are we doing with all this controllable water? We control 1800 cubic kilometers by dams and reservoirs. We control another 1200 cubic kilometers by well fields. Nearly all the remaining controllable water is in the ground; twice as much water as we actually use in one year.

Options Defined

Our first course of action is to stop bellyaching and start implementing some management options that will work. We also need to evaluate just where we are not efficiently using our water and eliminate some of those practices. Remember this course of action may step on people's toes and even be politically unpopular, but throwing good money after bad is not a good management practice.

Evaluation of inefficient irrigation practices is one step. The Israelis who also have a "water shortage" and excellent management of

the resource have achieved irrigation efficiencies of 60%. Practices such as drip irrigation, irrigation which takes advantage of higher humidity, and irrigation in response to soil or crop demand are all management techniques to reduce water consumption.

Use of both surface and ground water in concert, called conjunctive use, can help reduce the impact of localized droughts. The East is prone to droughts and water shortages because of an overdependence on surface supplies. Every 10 years or so the reservoirs dry up and people cry that there's not enough water to go around. The answer to both problems of dependence on one source of supply is to have a back-up specially made for crises like these. The wise development of a blend of surface and ground water is a management option.

Perhaps one of the most neglected management options is that of artificial recharge. What better way to conserve water than to use the ground as a giant storage system. There is no loss to evaporation as with a surface reservoir and many sources of water which normally flow out of the watershed can be recycled and saved right there in your own backyard. Artificial recharge is not a new idea. Records indicate as early as 1890 that Denver, Colorado had discovered the value of the technique. The Californians have been using artificial recharge and have reaped the economic benefits as well. It is estimated that nearly 40% of the water used in Los Angeles comes from aquifers that have been artificially recharged. What's the value of the water? -- over 50 million dollars!

The Bottom Line

The world is not running out of water. It's suffering from a lack of good management and common sense. It's suffering from a shortage of people who aren't afraid to step on toes and buck the political system. Sure there will always be water shortages, but their number and frequency can be reduced significantly when we start to set our course in the right direction and don't get swayed by promises of what we could have if we were willing to pay the cost. It's time to tighten the purse strings and make some decisions. It's time for management.

HEALTH EFFECTS OF DRINKING WATER CONTAMINANTS

by
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Introduction

In regards to drinking water and your health, there is mostly good news. Good, in the fact that drinking water is essential for life; the quality of our drinking water is relatively good; and people are concerned enough about the quality of potable water to insure that good public health practices are maintained and/or pursued.

Today, I would like to share with you my own thoughts, not necessarily that of the U.S. EPA, about drinking water and your health. To accomplish this, let me briefly cover:

1. History of drinking water standards
2. Application of toxicological principles
3. Health effects of microorganisms, inorganics, radionuclides and organic chemicals
4. Comparative toxicity of drinking water contaminants

I. History of Standards

Sanskrit medical lore suggests that man, early on, realized that ingesting good water results in feeling better and living longer. Hippocrates (460-354 B.C.), the Father of Medicine, wrote that "whosoever wishes to investigate medicine properly should consider the seasons of the year, the winds and the waters in relation to health and disease" (Ba 49). Man's first pursuit for good drinking water was based on possible health implications and occurred many centuries prior to the "germ theory" which was established by Pasteur, Koch and others in the late eighteen hundreds, A.D.

The U.S. PHS published five sets of drinking water regulations over a 48 year period (1914, 1925, 1943, 1946 and 1962). The 1914 standards were primarily established in response to an incident on the Great Lakes in 1913. The PHS investigation showed that 235 passengers drank contaminated water while on a streamer and 122 cases of gastroenteritis, 42 cases of typhoid-like attacks, including five deaths occurred (Be 83). The 1914 standards were established to protect the traveling public (Ho 78).

The 1914 recommended limits addressed only bacteria. However, these first regulations did appreciate the need to maintain a balance between potential health risks and cost. The 1925 drinking water standards were much more comprehensive than the set of '14. The standards of '25 not only addressed

bacteria but also physical and chemical characteristics of acceptable water supplies. The '25 regulations introduced the concept of a "sanitary survey" for the purpose of visually evaluating the water source, treatment processes and distribution system. The 1943 and 1946 standards accommodated additional concerns about human exposure to bacteria, inorganics and faulty distribution systems. In 1962, the PHS specified limits for radioactivity where Ra-226 alone could not exceed 3 pCi/l and Sr-90 could not exceed 10 pCi/l.

In 1974, the 93rd U.S. Congress passed Public Law 93-523 (Safe Drinking Water Act) which allowed EPA, not the PHS, for the first time to promulgate drinking water standards which (a) legally could address all constituents in drinking water, not just bacteria as specified in the Interstate Quarantine Act, and (b) legally should apply to all water supplies having 15 service connections or regularly served at least 25 individuals.

From a health perspective the Safe Drinking Water Act (SDWA) essentially required EPA to (a) develop primary standards for all contaminants in drinking water which posed a threat to human health whether the stressors are organics, inorganics, microorganisms and/or radionuclides, (b) develop Health Advisories (HAs) for emergency situations, and (c) maintain a laboratory certification program to assure good quality assurance. The EPA was instructed by Congress to (a) work with the NAS or some equivalent body to produce Recommended Maximum Contaminant Levels (RMCLs) for undesireable pollutants in drinking water, and (b) promulgate Maximum Contaminant Levels (MCLs) or treatment standards after considering not only the RMCLs but occurrence, treatment and associated costs.

The SDWA clearly specified that the RMCLs must consider a substantial amount of scientific information, namely: (a) more sensitive members of the population, (b) relative source contribution (intake from food, water and air as well as the occupational setting), (c) body burden and resulting health effects, and (d) synergism.

The EPA promulgated interim regulations for several constituents in drinking water that impact human health in 1975 (microorganisms, inorganics and some pesticides). EPA specified limits for radioactivity in drinking water in 1976.

Over the last five years EPA has provided health guidance in the form of Health Advisories to assist States and communities impacted by contaminated drinking water for which no standards exist (La 83). A Laboratory Certification Manual was published in 1982.

II. Application of Toxicological Principles

Simplistically, the determination of an "acceptable daily intake concentration" (ADIC) is a two-step process where the level is calculated first for the case where 100% of the constituent comes from drinking water, and secondly, where the other sources of exposure are also taken into consideration. Based primarily on toxicological data and associated perhaps with epidemiological data, it is possible to roughly calculate an ADIC for drinking water only.

Determining the "acceptable daily intake concentration" for drinking water when all sources of exposure are taken into account (ADIC-RSC) is more difficult. In this case, not only must the ADIC (100% drinking water) be determined, but the relative source contribution needs to be determined for food, water, air, etc. and specified in percent. Specification of a relative dose contribution is even more appropriate.

Assessment of the health impact of contaminants in drinking water is not a cut-n-dried, cook-book process as many naive people would like to think or claim. A good understanding of dose and response is required. Many problems and issues need to be resolved on a case-by-case basis.

Finished drinking water normally contains chemicals and radionuclides at such minute levels that no immediate, non-carcinogenic health effect is likely to occur. If immediate health effects do occur, it is usually the result of heavy contamination that results from a spill or other careless, man-made process. Carcinogenic bioeffects may also occur from contaminants in drinking water, but usually as a result of long-term exposure to substantial levels. Carcinogenic bioeffects take years to decades to express themselves.

Environmental health scientists utilize two different methods to address non-carcinogenic and carcinogenic bioeffects. The non-carcinogenic risk estimate involves the process of determining an acceptable daily intake concentration (ADIC) as described earlier. The cancer risk estimate also requires the use of animals but includes an extrapolation process which utilizes one or more models. Many different models are used for cancer risk estimation whereby risks can be estimated first for the individual and second for the population (population risk).

In regards to extrapolation the NAS reassured the scientific community when it established principles to follow for evaluating carcinogenic responses. (Table 1)

Table 1. Principles For Extrapolating Cancer Risks

- Effects in animals are applicable to man if properly qualified.
- Methods don't exist for accurately establishing any threshold for long-term toxic effects.
- Valid to extrapolate from high doses in animals to low doses in man to estimate carcinogenic responses.
- Exposures should be assessed in terms of human risk rather than "safe" vs. "unsafe".

Source: NAS, 1977 and 1980. Drinking Water and Health.

Cancer risk estimation is both complex and simplistic and appears to be more precise than is warranted. Furthermore, many issues need resolution.

III. Inorganic Constituents In Drinking Water

Unlike radionuclides, solvents, pesticides, many bacteria and viruses; approximately one-half of the common inorganics in drinking water are essential for life; the other half being both non-essential and toxic. The essential inorganics can also be toxic depending upon the species, route of exposure, toxicokinetics, dose and human susceptability. Speciation of inorganics in drinking water is a complex field in itself, and needs considerable delineation. In order to address inorganics in drinking water properly, it is important to discuss (1) human exposure, (2) beneficial effects and (3) toxicological effects.

Human exposure to inorganics is largely via food, some via drinking water, with minor amounts normally coming from ambient air (Table 2).

Relative source contribution data suggests that focusing in on SO_4, Pb, asbestos, F, V, Hg, possibly Ca, NO_3, Cr, Cu & Ba is warranted from a drinking water point-of-view in the United States.

Inorganics can be divided into those that are beneficial (needed for nutrition) and those that are not essential for human life (Table 3). Of the inorganics having significant RSC factors (> 10% intake), half are beneficial (Ca, Cu, F, Cr & V?); the other half being non-essential (SO_4, asbestos, Ba, NO_3, Hg & Pb).

In terms of mineral metabolism drinking water is really only important for Ca and possibly Cu. Drinking water may be useful for some intake of Mg, Zn, Mn, F, Mo, Cr^{+3} & V (?). The intake of several other inorganics, useful for mineral metabolism, are "not needed" via drinking water because intake via food meets our needs. Inorganics in this category include K, Na, P, Cl, Fe, Se & I.

The drinking water contribution from Ni & As are undesireable because the intake from food meets any possible mineral metabolic need & because these two inorganics are also toxic to humans. Chromium is a special case where Cr^{+3} is needed while Cr^{+6} is toxic. Suggested intakes, of course, are age-dependent where infants, children & adults need increasing amounts of selected inorganics.

Table 2. Occurrence and Relative Source Contribution of Inorganics for Adults

Constituent	Daily Intake (mg/day)			Relative Source Contribution (%)		
	Drinking Water	Food	Air	Drinking Water	Food	Air
Potassium	4.3	3750	?	< 1	> 99	-
Calcium	100	320	?	24	76	-
Sodium	56	5600	?	< 1	> 99	-
Phosphorus	0.2	1500	?	< 1	> 99	-
Chloride	40	8400	?	< 1	> 99	-
Magnesium	12.5	360	?	3	97	-
Zinc	0.35	12.5	?	3	97	-
Iron	0.5	19	?	3	97	-
Manganese	0.6	3.7	?	2	98	-
Copper	0.2	1.5	?	12	88	-
Fluoride	0.8	0.9	?	47	53	-
Molybdenum	0.002	0.335	<0.001	< 1	99	< 1
Selenium	0.016	0.169	<0.001	8	91	< 1
Iodine	0.008	0.5	?	2	98	-
Chromium	0.015	0.1	<0.001	13	87	< 1
Beryllium	0.001	0.011	<0.001	8	92	< 1
Thallium	?	?	?	-	-	-
Sulfate	92	?	?	-	-	-
Antimony	?	?	?	-	-	-
Aluminum	0.050	30	?	< 1	99	< 1
Asbestos	2 x 10^5 fibers	?	$2x10^5$ fibers	< 50	?	< 50
Nickel	0.010	0.330	<0.001	3	97	< 1
Vanadium	0.009	0.020	<0.001	30	67	3
Cyanide	?	?	?	-	-	-
Barium	0.086	0.670	0.017	11	87	2
Silver	0.005	0.070	<0.001	7	93	< 1
Nitrate	20	100	40 siliva)	13	62	25 (siliva)
Arsenic	0.003	0.062	0.001	5	93	2
Mercury	0.002	0.004*	0.001	29	57	14
Lead	0.068	0.050	0.001	57	42	1
Cadmium	0.001	0.027	0.003**	3	87	2

*Inorganic, not methyl mercury
**Via ambient air (0.23 ug/day) and smoking association (3 ug/day)

Sources: ICRP ('74), NAS ('80), FDA ('82), EPA ('84), AWWA ('84) and Author ('84)

Table 3. Suggested Daily Intakes Of Inorganics For Beneficial Effects*

Constituent	Suggested Intakes (mg/day)		
	Infant	Child	Adult
Potassium	800	2,550	3,750
Calcium	450	800	800
Sodium	430	1,500	2,200
Phosphorus	320	800	800
Chloride	260	?	5,950(?)
Magnesium	65	200	350
Zinc	7	15	15
Iron	12	12	14
Manganese	0.7	3	3.7
Copper	0.7	2	2
Fluoride	0.6	1	2.7
Molybdenum	0.05	0.27	0.3
Selenium	0.04	0.1	0.12
Iodine	0.04	0.08	0.13
Chromium	0.03	0.1	0.1
Beryllium	None	None	None
Thallium	None	None	None
Sulfate	None	None	None
Antimony	None	None	None
Aluminum	None	None	Unknown
Asbestos	None	None	None
Nickel	Unknown	Unknown	0.05?
Vanadium	Unknown	Unknown	0.02?
Cyanide	None	None	None
Barium	None	None	None
Silver	None	None	None
Nitrate	None	None	None
Nitrite	None	None	None
Arsenic	Unknown	Unknown	0.03?
Mercury	None	None	None
Lead	None	None	None
Cadmium	None	None	None

*Numbers are approximate values for each age group and should be used for comparative purposes between elements. Precise values should be specified by your physician to meet your special needs, especially for those members of the population suffering from metabolic disorders.

Source: Modified NAS ('77, '80), And Author ('84)

The bioeffects of inorganics need to be specified as to both deficiency and toxicity. In other words, for the inorganics useful for mineral metabolism, too little causes a deficiency and too much causes toxicity. A happy medium or "window" is essential for good health. In some cases, i.e. F, the window is extremely small where < or > 1 mg/l causes undesireable bioeffects. Inorganic constituents in drinking water are not carcinogenic, the only possible exception being asbestos. Nitrates and nitrites have been speculated to be precursors.

The non-carcinogenic toxicity of the inorganics found in drinking water varies from only gastrointestinal irritation to anemia, liver, kidney and nervous system disorders to name a few. Of course, any particular inorganic can and probably does affect more than one organ system. For simplistic purposes, however, inorganics in drinking water could be placed into categories.

A comparative picture of the toxicity of inorganics in drinking water warrants investigation. Using non-carcinogenic data as a basis, comparing ADI's would be a starting place. However, ADI's are often a function of both toxicity and experimental designs. In addition, comparison of the suggested levels with the ADI's provides some appreciation of the deficiency-toxicity window. ADI values can be lower than suggested levels. This phenomena, however, is not surprising since ADI's do have safety factors and since constituents can be both toxic and beneficial in some cases.

IV. Organics

For centuries man obtained his drinking water primarily from surface water sources. As surface waters became polluted and man's requirements also increased for additional drinking water, the use of ground water also increased, especially over the past 50 years. Until recently man refrained from intentionally polluting this underground resource (i.e., underground injection of radionuclides). Synthetic chemicals released to streams or stored at surface disposal sites were not thought to jeopardize the quality of our groundwaters. Unfortunately, man was careless and wrong. Furthermore, the cleansing time for groundwater far exceeds that of surface water.

The organic contaminants present in drinking water are largely non-volatile, only 10% being volatile. Only 5-10% of the nonvolatile chemicals have ever been identified (NAS 77).

A. Solvents

Our understanding of the occurrence of organic chemicals in drinking water in the U.S. is poor at best. There have been some six major surveys, however, to look at the problem, namely:

(1) National Organics Reconnaissance Survey
(2) National Organics Monitoring Survey
(3) National Screening Program for Organics in Drinking Water
(4) Community Water Supply Survey
(5) Rural Water Survey
(6) Ground Water Screening Survey

Since our knowledge is weak, perhaps it is best to make only a few general statements:

(1) Approximately 75 million people are served by groundwater sources while approximately 150 million people are served by surface water sources.

(2) There is more surface water contamination at lower levels and more ground water contamination at higher levels.

(3) Approximately five million people in the U.S. are exposed to $\leq$ 0.5 ug solvents/l via groundwater sources while approximately 10 million people receive their drinking water from contaminated surface water sources having $\leq$ 0.5 ug/l (EPA '84).

In order to appreciate the health impact of these solvents, one must address both their non-carcinogenic bioeffects and their carcinogenic potential (Table 4). These chemicals by-and-large affect the liver, kidney, hematopoietic and nervous system. Carbon tetrachloride causes fatty infiltration of the liver, for example, benzene attacks the hematopoietic system and causes leukemia and dichloromethane affects the oxygen-carrying capacity of the blood via the formation of carboxyhemoglobin. Acceptable daily intake concentrations, specified by EPA as Adjusted ADI's (EPA 84) would suggest, that based upon non-carcinogenic bioeffects, the decreasing order of toxicity is benzene > carbon tetrachloride > tetrachloroethylene, etc. Based on ADI values, three levels of toxicity seems to exist for many of the solvents, specifically 0.05 mg/day for benzene and carbon tetrachloride, 0.5 mg/day for several chlorinated ethylenes, and 5 mg/day for many chlorinated benzenes.

Using the multi-stage model and estimates made by NAS and/or EPA a ranking of the carcinogenic potential is also possible: 1,1-dichloroethylene > carbon tetrachloride > 1,2-dichloroethane > tetrachloroethylene > benzene >> chlorobenzene > trichloroethylene >>> 1,1,1-trichloroethane. Note that cis- and trans-1,2-dichloroethylenes, o, m, p-dichlorobenzenes and dichloromethane are not judged as carcinogens. Even though 1,1-dichloroethylene has a relatively high cancer risk rate, most evidence would indicate that it is not carcinogenic. This author seriously questions whether or not the so-called VOC carcinogens are carcinogenic at all at drinking water levels. Furthermore, there is little doubt that the cancer risk estimates are at best overestimates and probably by approximately 100 fold. It is also interesting to note, in general, that those solvents considered to be carcinogenic are often the more toxic, based on non-carcinogenic data as indicated by lower ADI values.

Another way of looking at the lifetime cancer risk from solvents in drinking water is to determine (1) the population-concentration of these chemicals, and (2) the population risk.

Modifying the work of Cothern et al. (84) it would appear that, at worst, approximately 1000 excess cancers will occur in the U.S. population over the next 70 years from solvents in drinking water. Since the process of estimating cancer risk probably exaggerates in the direction of overestimation, the real mortality rate probably is closer to 100/lifetime or 1-10 extra cancers/year for the U.S. population. Carbon tetrachloride, itself, seems to be responsible for one-third of the projected cases of mortality.

Table 4. Health Effects Of Solvents In Drinking Water

Chemical	Non-Carcinogenic Bioeffect				ADI (mg/day)	Conc. (ug/l) for 10^{-5} Excess Cancer Rate
	Liver	Kidney	Nervous System	Blood		
Benzene				X	0.05	6.8
Carbon tetrachloride	X	X	†		0.05	4.2
Tetrachloro-ethylene	X	X	†		0.17	6.6
1,2-dichloro-ethane	X	X	†		0.52	6.0
Dichloromethane				X*	0.52	N/A
Trichloro-ethylene	X		†		0.52	28
1,1-dichloro-ethylene	X	X	†		0.70	2.4(?)
cis-1,2-dichloro-ethylene	X	X	†		0.70	N/A
trans-1,2-dichloro-ethylene	X	X	†		0.70	N/A
1,1,1-trichloro-ethane	X				2.00	220
Chlorobenzene	X	X	†	X	6.00	24
o-dichlorobenzene	X	X	†	X(?)	6.20	N/A
m-dichlorobenzene	X	X	†	X(?)	6.20	N/A
p-dichlorobenzene	X	X	†	X(?)	7.50	Yes

X = via drinking water

† = via inhalation or high drinking water levels

* = Carboxyhemoglobin formation

B. Trihalomethanes

Trihalomethanes (THMs) occur in drinking water as a result of the disinfection process. Chlorine and/or bromine used to disinfect source water, primarily surface water, combines with many natural humic and fulvic substances resulting in the formation of primarily chloroform but also bromodichloromethane, dibromochloromethane, bromoform, etc. The average concentration of chloroform is approximately 20 ug/l while that for the other THMs is small (i.e., bromoform $\leq$ 1 ug/l) (NAS 77). Perhaps 25 ug/l could be considered the average level of TTHMs in U.S. drinking water.

The NAS specified a cancer risk estimate (NAS 77) of 1.7×10^{-6} per ug/l over a lifetime. If one assumes the consumption of 2 l/day; then 0.8, 8, 80 ug/l would be expected to cause one excess cancer per million, 100 thousand, 10 thousand/lifetime, respectively. A population risk of 5,000 excess cancers over a lifetime would be expected if the assumptions were made that the average TTHM level in the entire U.S. is 25 ug/l and that all the THMs have similar carcinogenic potential to that of chloroform.

V. Microorganisms In Drinking Water

Unlike most inorganics, organics and radionuclides in drinking water; many bacteria, protozoans and viruses can cause immediate or acute health problems. The outbreaks and illnesses range from gastrointestinal irritation to salmonellosis/ shigellosis to infectious heptatis A.

Considerable effort has been spent over the decades to correlate waterborne disease with (1) type of water supply (community vs. non-community vs. individual), (2) source of water (surface vs. ground), and (3) population exposure, and (4) health effects including disease outbreaks and cases of illness (Figure 1).

Table 5. Salient Points About Waterborne Disease And Water Supply Type, Source And Population Exposure In The U.S.

1. There are 224,000 public water supplies (PWS) in the U.S. and countless numbers of private (individual) supplies (10 million).

2. Of the PWS, 26% are community water supplies and 74% are non-community water supplies.

3. For the community water supplies, 19% obtain their source water from surface water and 81% from ground water.

4. For the non-community water supplies, 3% obtain their source water from surface water and 97% from ground water.

5. For the community water supplies, surface water is used to serve 66% of the people while ground water is the source for 34% of the people.

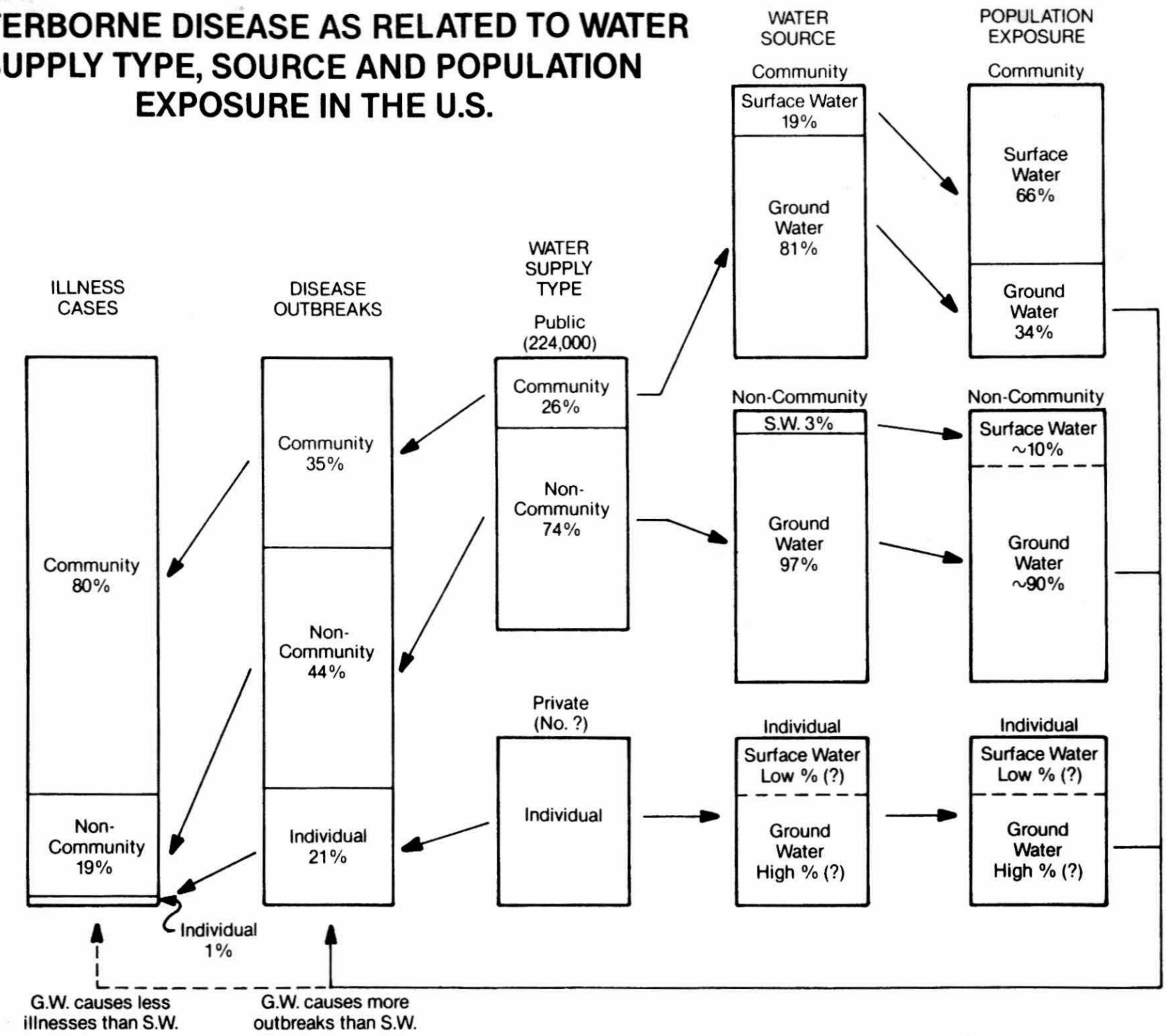
6. For non-community water supplies, the resulting population exposure is not well understood, however, ground water is assumed to account for a greater population exposure than is surface water.

7. For private supplies, ground water is the major source and thus contributes to a greater population exposure than does surface waters.

8. Community, non-community and private water supplies are responsible for 35, 44 and 21%, respectively, of the number of outbreaks, the majority occurring during the warmer months.

9. Community, non-community and private water supplies, however, are responsible for 80, 19 and 1%, respectively, of the cases of illness.

WATERBORNE DISEASE AS RELATED TO WATER SUPPLY TYPE, SOURCE AND POPULATION EXPOSURE IN THE U.S.



10. Ground water causes more outbreaks than surface water because ground waters are often not disinfected.

11. Surface water causes more cases of illness than ground water simply because more people drink surface water.

12. Overall, there has been approximately 800 reported waterborne outbreaks in the U.S. over the last forty years. Assuming that 60% of the outbreaks went unreported, the true number of outbreaks in the U.S. over the last forty years is probably near 1300. Furthermore, the number of reported outbreaks seems to be increasing.

13. Extrapolating the number of cases of illness specified by Lippy and Waltrip ('84) from 35 to 40 years, it is reasonable to assume that over the last forty years, approximately 175,000-200,000 waterborne illnesses were reported. Furthermore, 300,000 cases probably actually occurred over that 40 year period (1946-1986) if a 60% reporting rate is assumed.

A. Bacteria

Bacteria of all types can occur in drinking water. However, enteric bacteria (Enterobacteriaceae) have priority in terms of protecting public health. Evaluation of the outbreak and illness data for the enteric bacteria strongly suggest that Salmonella and Shigella are of greatest concern. The national impact of opportunistic pathogens, like Legionella, remains uncertain even though their presence in ambient water is wide-spread.

B. Protozoans

The two protozoans of greatest concern in the United States are Giardia lamblia and Entamoeba histolytica. Giardia is found primarily in surface waters and is associated with drinking water that is inadequately treated. Giardia causes gastrointestinal disturbances, diarrhea and general discomfort. Entamoeba histolytica is associated with sewage contamination but is not considered the problem it once was with the installation of sewage treatment plants. It can, however, occur if untreated sewage seeps into water distribution lines/systems. Entamoeba histolytica does cause severe outbreaks of dysentery in many other parts of the world, resulting in abscesses of the liver and other organs.

C. Viruses

Viruses occur both in ground water and surface water. Human viruses in drinking water are associated with sewage and septic tanks. Ground water may be a more significant

viral health problem since ground water, as opposed to surface water, often is not disinfected. In terms of drinking water and health, enteric viruses could be grouped according to the number of outbreaks and cases of illness as well as public health severity. Enteroviruses are the most common but are now not a problem in the U.S. with polio behind us.

Health effects of viruses in drinking water in the U.S. are not clearly understood and much work remains unfinished. At least three of six types of viruses do cause disease.

D. Relationship Between Exposure and Disease

Utilizing the number of outbreaks and cases of illness caused by various bacteria, protozoans and viruses as specified by Lippy & Waltrip ('84), CDC ('82), and EPA ('84), a comparison of the microorganisms responsible for causing waterborne disease in the U.S. can be estimated and expressed in percent. The order of comparative risk of coming down with a waterborne disease can be prioritized such that bacteria > protozoans > viruses. It should be remembered, however, that in only 50% of the outbreaks has the etiological agent been determined. Therefore, it is possible that viruses, which are hard to monitor, could make up a significant portion of the 50% unknown.

VI. Radioactivity In Drinking Water

A. Occurrence

Radioactivity in drinking water occurs naturally as a result of radionuclides in soil and rocks being released to ground and surface water. It can also occur because of man's activity to generate power, produce military devices, mining operations for phosphate, minerals and so on. Radionuclides are true carcinogens and contaminated water definitely imposes a health risk upon its consumer. Furthermore, unlike many of the inorganics, radionuclides are not beneficial and a radionuclide "deficiency" is not a variable for consideration.

Radium occurs primarily in ground water, not surface water, and is concentrated in the Coastal Plains, Piedmont, North-Central, and Colorado Plateau and includes the States of New Jersey, Connecticut, Virginia, North Carolina, South Carolina, Georgia, Minnesota, Wisconsin, Iowa, Illinois, Missouri, Utah, Colorado, Arizona and New Mexico. The average national drinking water concentration in the U.S. is 1-2 pCi/l.

Natural uranium is found in both surface and ground water. The U-234/U-238 ratio may vary from <1 to 28 so mass determinations can be deceptive. Five major geological provinces are involved, namely: Western Central Platform, Rocky Mountain System, Colorado Plateau, Basin and Range, and the Pacific Mountain System. At least 12 states have elevated levels: South Dakota, Nevada, New Mexico, California, Wyoming, Texas, Arizona, Oklahoma, Colorado, Nebraska, Montana, and Kansas. The population-weighted average is 0.8 pCi/l with South Dakota having the highest value, 6.7 pCi/l.

The occurrence of natural uranium in U.S. drinking water has been evaluated by ORNL ('83) using the NURE data and by Cothern and Lappenbusch ('83). The average U concentration in surface, ground and domestic water is 1, 3, 2 pCi/l, respectively. The number of community water supplies estimated to exceed 20, 10 or 5 pCi/l is significant.

Radon (Rn-222) in drinking water comes primarily from the physical decay of Ra-226. Rn-222 is found in ground water, not surface water, especially in New England and the Appalachian region (Figure 2). The States of Maine, New Hampshire, Vermont, Rhode Island and Massachusetts are especially impacted. Pennsylvania and Virginia also have substantial levels. Radon enters the home via the distribution system and substantial doses can be received by the occupants. It has been shown that the smaller the distribution system, the more likely that higher concentrations will prevail. The population-weighted average for the U.S. ranges from 187 pCi/l (geom.) to 944 pCi/l (arith). Some 500 pCi/l seems about right for our estimate at this time.

Drinking water is responsible for a significant fraction of one's normal intake of natural radioactivity. Drinking water accounts for 80, 68, and 8% of Ra, U and Rn, respectively.

B. Health Effects

The risk to the U.S. population from radioactivity in drinking water over a lifetime of 70 years is approximately 23,000 or 330 excess mortalities per year each year (Table 6). Rn is responsible for the vast majority of these early deaths (90%) with Ra-226 (1800) and U-234/U-238 in equilibrium (625) responsible for 7% and 3%, respectively.

VII. Conclusion

Natural radionuclides and the trihalomethanes are the most serious physical and chemical contaminants in drinking water from a health perspective. Radon (Rn-222) is definitely the more undesireable constituent in drinking water from a population risk point of view. There is no benefit of having radionuclides in drinking water, the lower the concentration the better. Trihalomethanes form as a result of the disinfection process and thus a good argument can be made for experiencing the added risk in order to partially protect ourselves from many human pathogens. Pesticides in drinking water remain unknown in terms of actual occurrence and risk to the population. Solvents from a population risk perspective are negligible; however, accidents and releases from disposal/waste sites may impact the relatively few people near their boundaries. Caution is warranted in such cases.

Table 6. Population Risk From Natural Radioactivity In U.S. Drinking Water

Radio-nuclide	Drinking Water Conc. (pCi/l)	Exposed Population	Excess Cancer Risk Rate (cases/lifetime/person/#pCi/l)	Population Risk
Ra-226	1.6	70×10^6	0.8×10^{-4}/5 pCi/l	1,792
U-234/ U-238 (Equilibrium)	0.8	230×10^6	34×10^{-6}/10 pCi/l	625
Rn-222	500	70×10^6	6×10^{-7}/1 pCi/l	21,000
Total (less Ra-228)	--	--	----	23,417

FOOTNOTE

Preparation and presentation of this paper was done on the author's own time and reflects his scientific opinions and does not reflect EPA policy one way or another.

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WATER TECHNOLOGY IN ONTARIO

by

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Rather than deal with an overview of Water Technology in Ontario which encompasses all aspects of drinking water treatment and distribution, this presentation has been split into three segments. These typify the efforts which need to be focussed in order to ensure a high quality, safe drinking water for the people of Ontario.

The segments are:

a) Development of drinking water objectives, (Ontario). Guidelines, standards, criteria, regulations used by other jurisdictions are developed similarly.

b) Discussion of a newly instituted Drinking Water Assessment Program which will obtain and maintain a data base for:

   i) Drinking Water Objective parameters
   ii) 'Exotic', 'new' etc. organic parameters

c) The pilot plant study to be carried out at the Niagara Falls WTP over the next 2½ years to investigate the efficiency of various process options for the removal of trace organic contaminants.

DRINKING WATER OBJECTIVES

The primary purpose of drinking water limits is for the protection of public health. Water for human consumption should not contain disease-causing organisms or hazardous concentrations of toxic chemicals.

Disease-causing organisms generally cause acute health effects and thus "the price of freedom from waterborne disease is eternal vigilance". Treatment operation must be at peak efficiency at all times. Optimum coagulation, flocculation and filtration with the correct chlorine residual need to be maintained at all times.

Most chemical compounds would potentially cause chronic (long-term) health effects which normally allows more time to take corrective action. In general we can say that the concentration of most toxic chemicals in drinking water is so low that it is difficult to predict potentially adverse effects from the drinking water.

It is interesting to consider how the acceptable levels of exposure to various chemical agents in water have been developed. Historically, two approaches have been taken to estimate a level of exposure which is considered without significant risk or "safe".

One approach is based on the application of "safety factors" to levels of the chemicals that did not produce an observed effect in "animal" studies.

The other approach that has been used is based on "extrapolation" of experimental dose-effect curves to lower dose levels where no data existed. This method was first used to estimate risk from low levels of radiation.

Both these approaches yield a number which is the amount of that substance that is considered safe for humans to ingest. Considering all possible sources e.g. food, air, water, the amount that could be present in drinking water without causing an adverse effect can then be calculated. This amount then forms the basis for the maximum acceptable concentration (M.A.C.) in drinking water.

The Safety Factor Approach:

The A.D.I. of a chemical is defined as the dose that is anticipated to be without lifetime risk when taken daily. It is not assumed that this dose guarantees absolute safety.

In the development of the A.D.I. "safety factors" based on "quality" of data are applied to the highest no-observable-effect dose found in animal studies. Quality of data may refer to the magnitude of the data base, the type of animal tested, similarity to other compounds etc.

The concept of safety factors and the development of A.D.I.'s arose in the early days of food additive legislation when it became apparent that there was no universally acceptable quantitative method for extrapolating from animals to humans. The use of safety or uncertainty factors in translating animal toxicity data to acceptable exposure levels for humans has been the cornerstone of regulatory toxicology.

The originators of the safety factor concept of "hundredfold safety factor" used this as a practical means of handling the uncertainties involved in interpretation. They considered animals may be more resistant to the toxic effects of chemicals than are humans. Therefore, they used a safety factor of ten when translating the data from animals to humans. Another factor of ten was used to account for differential sensitivities within the human population. This concept of a hundredfold safety factor in regulatory toxicology pertaining to food additives has been endorsed by such international organizations as the World Health Organization. The F.A.O./W.H.O.* Committee pointed out further limitations and expressed reservations regarding the use of A.D.I. Certain aspects are considered when arriving at an A.D.I.

For example:

- animal species and different susceptibility;
- strain of animal;
- sex differences;
- variations in susceptibility among exposed individuals;
- insufficient animal data;
- food additives and contaminants consumed by people of all ages throughout life;
- consumed by sick as well as healthy and
- variation in exposure pattern.

*Food & Agriculture Organization/World Health Organization

Therefore, F.A.O./W.H.O. Expert Committee on Food Additives do not always use the hundredfold safety factor but modify it to take into account lack of availability of information on a particular substance along with the other factors mentioned above.

A simple example using the safety factor approach to the A.D.I. will illustrate:

A.D.I. (for animal) = 1 mg/Kg/day,
thus for man of 70 kg this gives a 70 mg/day acceptable intake.
If we estimate 50% intake of substance from food and 20% intake from air, this leaves 30% for water ie
21 mg/day
Applying a safety factor of 100 and assuming 2L/day ingestion we arrive at a calculated acceptable concentration of -

$$\frac{21}{100} \text{ mg/day} \div 2 \text{ L/day} = 0.105 \text{ mg/L}$$

Obviously in this case a value of 0.1 mg/L would be chosen as the MAC*.

The Risk Estimate Approach:

For the risk estimate approach, adequate dose-response curves must exist for the purpose of extrapolation. A dose-response curve relates the dosage of the chemical applied to the response effect on animals. This data may not exist for the majority of chemicals that may be detected in drinking water; in these cases, for non-carcinogens, the A.D.I. approach is recommended until sufficient data are available.

Numerous factors must be considered when extrapolating from high to low dose levels, depending upon the type of chemical, metabolism of the animal, etc.

Extrapolation is normally accomplished using models such as:

a) Margin of safety
b) One-hit
c) Two-step
d) Probit-logarithm

The models are basically logarithmic in nature and agree fairly closely in the area of dose-response where data exists. The problems of different risk assessment approaches begin when extrapolation to low concentrations is made. A wide variation in calculated numbers can occur. Differences in MAC's developed by various agencies may be because a different risk assessment extrapolation model was selected for the exercise; this can result in a difference in MAC even though the same toxicological data were used in the calculation, e.g. The models are statistical in nature and assume that a calculable risk exists regardless of the size of the dose.

*MAC - Maximum Acceptable Concentration

For carcinogens, the model chosen will calculate a risk estimate number in terms of excess cancers per exposed population for the ingestion of the chemical in question as mg/kg.

The calculation of an MAC follows a similar pattern to that for the ADI using this risk estimate number.

DRINKING WATER ASSESSMENT PROGRAM

The Drinking Water Assessment Program (DWAP) will establish a centrally-controlled, readily accessible data base for public information on current drinking water quality in Ontario; the program was developed by the Ministry of the Environment, Laboratory Services and Applied Research Branch in cooperation with the Water Resources Branch[1]. Reliable and current data will be gathered for a wide range of parameters and integrated with other pertinent information. The program is dynamic in design in that additional parameters can be added and monitored almost immediately. The Ministry will thus be able to maintain an ongoing picture of drinking water quality in the Province, allowing a quick response to public concerns.

Objectives

The program will provide:

- immediate reliable, and current information on water quality and contaminant levels;
- a "flagging" system for exceedence of water quality "Objectives";
- a definition of contaminant levels and trends;
- the mechanism and the specific technical information for the assessment of new contaminants as they arise;
- a comprehensive basis for any necessary remedial action;
- a potential indication of drinking water plant treatment process efficiency

The program is designed to include all municipal water supplies in Ontario. Initially, based on such criteria as population density, probability of contamination and geographical location, thirty-five water supply locations have been chosen for surveillance. Twelve of these locations will be monitored in an 'intensive' mode (10 times per year), whereas the remainder will be monitored in a 'normal' mode (6 times per year). The population served by these supplies is in excess of 5 million representing 73% of the approximately 7,200,000 persons in the Province receiving water from piped, municipal systems.

[1] under the MOE reorganization (June 1984) co-ordination of the DWAP program has been transferred to the Drinking Water Section of Water Resources Branch.

Once the data base for the initial locations has been established, an assessment of monitoring requirements for the future will be made; monitoring will be continued at the initial locations at an appropriate level and will be commenced at further locations as manpower and dollar resources permit. Since the DWAP will replace existing programs, and incorporate critical and ongoing review of sampling needs, it will contribute to laboratory analytical load planning and reduction. It is estimated that after 5 years of operation, the program will be monitoring 114 locations assuming present laboratory capacity.

Samples will be taken of the raw and treated water at the treatment plants, and also in the distribution systems; to determine possible effects of distribution on water quality; both standing and flowing water in old and new sections of the distribution system will be sampled. Sampling will be carried out by Regional staff and/or Municipal personnel who have been trained in the applicable procedures. Comprehensive sampling kits supplied from the laboratory will be made available to samplers. This will ensure that samples are taken and shipped according to standard protocols and that field testing will supply reliable data. All analyses are to be carried out using approved, documented procedures.

The groups of analyses and scans, shown in Table I will be carried out on all samples. The substances analyzed for include the health-related Parameters from the Ontario Drinking Water Objectives, those identified by MOE Drinking Water Task Group in the development of a priority pollutant list, and chemicals recommended for monitoring in drinking water by the IJC Committee on Human Health Effects of Great Lakes Water Quality (1982-83). Dioxin analysis will only be carried out at selected sites at selected dates; GC/MS organic scans will be addressed in a similar manner.

General and field chemistry and bacteriological analysis, along with the metal scan and volatiles, PCB/OC scan with pesticides and chloroaromatic analysis will be carried out 10 times per year for the intensive monitoring mode and 6 times per year at 'normal' locations. Chlorophenols and specific pesticides will be analyzed 3 times per year from late spring to fall at 'intensively' monitored supplies, and in May and October for 'normal' locations.

The results of analysis and the field data will be entered in the MOE Laboratory's LIS/SIS data system, from which they can be retrieved using the specific data program developed for the Drinking Water Assessment Program.

In addition to analytical data, other information will be entered into the DWAP computer files, such as a full description of the treatment plant, its capacity, the processes employed and the treatment chemicals used, and the population served by the supply location. A catalogue of the parameters analysed will be maintained, which will contain relevant details on standards, guidelines, objectives, etc. for these, from Ontario and other jurisdictions and a summary of pertinent factors such as toxicological information, uses and manufacturing processes.

The DWAP data base will be maintained, with new analyses and supporting data being entered from the monitored locations on a continuous basis.

The DWAP will provide the following:

1. Annual reports on each of the surveillance locations. Such reports will include:

   a) up-to-date physical descriptions of the treatment process and distribution system including flows, processes, chemicals used, construction materials etc.

   b) a 5 year summary of laboratory and field data in tabular and graphical format to show ambient water quality trends, potential treatment efficiency trends, the effects of distribution, the effects of water standing in plumbing systems and the quality of water received by the consumer.

2. As data is collected, the program has the capability of issuing an 'Action Alert', whenever a measured health related parameter exceeds the 'objective' level set in the Ontario Drinking Water Objectives. A further feature of the program is its ability automatically to monitor trends; an 'Advisory' will be issued when data on a particular parameter undergoes a drastic increase, or exceeds any limit which has been set for that parameter eg. by another agency such as WHO.

3. Information stored in DWAP is readily accessible to answer enquiries about levels of various parameters in water supplies; support data enables rapid assessment and interpretation of such levels.

The reports and data from the DWAP will be used by:

a) The MOE Regions, by provision of current, accurate data on drinking water quality, to aid in the implementation of Regional drinking water programs (e.g. remedial actions, plant upgrading and uprating); the program will provide information for use in answering public enquiries and concerns. Regional staff will be able to access DWAP through the terminals in the Regional Offices.

b) (i) The Water Resources Branch for flagging of water supplies which exceed "Objectives" for one or more parameters. The DWAP data base is designed to be compatible with present monitoring systems and will assist in the preparation of "Operational Summaries" for water treatment plants. Information on ambient water quality and hence the impact of pollution inputs will be provided from analysis of raw water quality.

   (ii) The MOE Water Resources Branch, for research purposes since the data base will provide such information as water treatment plant unit process efficiency, distribution system effects, including any changes attributable to the materials from which the distribution system and plumbing are constructed.

c) The MOE Hazardous Contaminants and Standards Branch, in the identification and assessment of emerging contaminants of concerns and the setting of new objectives.

d) The general public, since accurate, reliable data on water quality can be made available, rapidly.

e) The analytical sections of the Laboratory Services Branch, by assisting in analytical load planning and reduction and in laboratory analytical method development.

f) The staff of the Ministry by the provision of up-to-date information on the properties, toxicology, impact etc. of each contaminant as an aid to data interpretation.

g) Senior MOE management, by the provision of annual reports to aid in the planning process and assist the Research Advisory Committee to identify areas in need of research funding.

TREATMENT TECHNOLOGY - INVESTIGATION OF PROCESS EFFICIENCY FOR TRACE ORGANIC REMOVALS

The Niagara Falls WTP Pilot Plant Study will investigate "Trace Organic Contaminant Removal from Drinking Water".

The work will be carried out by MacLaren Plansearch and is estimated to require 2½ to 3 years. Work is underway on the project. A steering committee has been set up comprising staff from this Ministry, Health and Welfare Canada and of internationally recognized experts in the field of trace organics and their removal from drinking water; Environment Canada are participating in the program as observers.

In light of the recent advances in analytical capabilities resulting in the detection of trace organics in raw water, there has been growing public concern for the quality of water used as sources for drinking water production.

Consequently, a re-examination of conventional treatment methodology for the removal of trace organics is required in addition to development of alternative possibilities such as activated carbon adsorption.

Objectives of the project are:

a) to assess the effectiveness of optimized conventional drinking water treatment for the removal of trace organic contaminants,

b) to assess the effectiveness of activated carbon adsorption removals of trace organic contaminants when used in add-on contactor mode,

c) to determine process design and operational parameters.

The optimization work will involve the use of 'new' coagulants and flocculants, pH adjustment, mixing energy etc. In addition work will be carried out as a desk-top exercise to examine the air stripping process for effectiveness in removing a range of volatile organic contaminants.

Pilot plant studies using a natural water source (the Niagara River has a consistent range of low level organic contaminants) will be carried out over a time frame to include at least the four seasons of the year.

The project comprises two distinct components:

Component I

Will include a review of existing data and pertinent literature, analytical and sampling protocol development, experiment design development and the physical design and equipment set-up. This analytical aspect is critical to the study with regard to the precision and accuracy of results needed for a treatment efficiency investigation.

Component II

Organic Removal Studies

a) Jar Testing

- -initial optimized "conventional" treatment choice
- -on-going optimization (possible seasonal variation)

b) Pilot Plant

- -conventional treatment removals of specific and overall organics
- -activated carbon adsorption removals of specific and overall organics; at least two types of activated carbons (GAC) will be investigated as a desk top exercise with one operated for the year in pilot GAC columns.

Summary

Three important aspects involved in the production of safe, high quality drinking water have been discussed. Firstly, the setting of guidelines which requires the availability of significant toxicological data and application of safety factors based on such things as quality of data, individual susceptibility and exposure was addressed. Secondly, the type of work needed to monitor for objectives and assess emerging trace contaminants was covered; and finally, a brief look at an on-going MOE project to examine the technologies associated with controlling and/or removing trace contaminants from drinking water for the development of process operational parameters for design purposes.

TABLE 1

GROUPS OF ANALYSES/SCANS

General Chemistry	(12 parameters)
Metals	(19 parameters)
Arsenic	(1 parameter)
Chlorophenols	(6 parameters)
PCB/chloroaromatic scan and pesticides	(34 parameters)
Specific pesticides	(6 parameters)
Volatile organic scan	(27 parameters)
Bacteriology	(3 parameters)

31ST ONTARIO INDUSTRIAL WASTE CONFERENCE

Prince Hotel, Toronto, Ontario
June 17-20, 1984

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M1P 4N8

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Dofasco Inc.
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Hamilton, Ont.
L8N 3J5

MCHOLM, Marilyn
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P. O. Box 85
Port Hope, Ont.
L1A 3V9

MCHUGH, R. D.
General Motors
Oshawa, Ont.

MCINTYRE, C. E.
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M4V 1M2

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Esso Petroleum Canada
P. O. Box 3004
Sarnia, Ont.

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Ontario Hydro
Box 1540
Tiverton, Ont.
NOG 2TO

MCLAREN, Christie
Globe & Mail
444 Front St. West
Toronto, Ont.

MCPHAIL, Wayne
Spectator
44 Frid Street
Hamilton, Ont.
L8W 3G3

MCTAVISH, Douglas
Environment Ontario
665 Cranbrook Road
London, Ont.
N6K 1W8

MICALLEF, Mario
The Foundation Co. of Canada
One YOnge Street
Toronto, Ont.
M5E 1E8

MILGRAM, Deena
Environment Ontario
62 Robert Street
Toronto, Ont.
M5S 2K3

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135 St. Clair Ave. West
Toronto, Ont.
M4V 1P5

MLADENOVICH, Peter
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1301 Fewster Drive
Mississauga, Ont.
L4W 1A2

MOHINDRA, Vinod K.
Bakelite Thermosets Ltd.
621 Dundas St. East
Belleville, Ont.
K8N 5C5

MONTEITH, J. G.
Regional Municipality of Peel
10 Peel Centre Drive
Brampton, Ont.
L6T 4B9

MORRIS, J. V.
Maclaren Plansearch Inc.
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Civic Square, P. O. Box 370
Sudbury, Ont.
P3E 4P2

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M5G 1X6

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Blackstone Industrial Products
Ltd.
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Stratford, Ont.
N5A 6T7

NICHOLS, Carroll
Hope Township
P. O. Box 85
Port Hope, Ont.
L1A 3V9

NORMAN, Jack
Pollutech Limited
1090 Speers Rd.
Oakville, Ont.
L6L 2X4

NOTTER, Erwin
Buhler-Miag (Canada) Ltd.
59 Curlew Drive
Don Mills, Ont.
M3A 2P8

NOWINA, Richard
Tricil (Sarnia) Ltd.
89 Queensway West
Mississauga, Ont.
L5B 2V2

NOYES, Richard
Noyes Manufacturing Ltd.
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Hamilton, Ont.
L9C 3J2

NUNN, Gerald
Water & Pollution Control
1450 Don Mills Rd.
Don Mills, Ont.
M3B 2X7

O'NEIL, Jim W.
TRicil Limited
89 Mississauga, Ont.
L5B 2V2

O'NEILL, Ted
Gartner Lee Assoc. Ltd.
Toronto Buttonville Airport
Markham, Ont.
L3P 3J9

ORCHARD, Deborah
Corpus Information Services
1450 Don Mills Rd.
Don Mills, Ont.
M3B 2X7

OTTON, Tim
Napier-Reid Ltd.
10 Alden Rd., Unit 2
Markham, Ont.
L3R 2S1

OWEN, J.
IBM Canada Ltd.
844 Don Mills Road
Don Mills, Ont.
M3C 1V7

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250 Windsor Ave.
Windsor, Ont.

PARIKH, B.
Work Wear Corp. of Cda.
940 Warden Ave.
Scarborough, Ont.
M1L 4C9

PARKER, Stan
Canadian Assoc. of Recycling
Industries
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Toronto, Ont.
M5E 1E1

PASCOE, Dave J.
EPS Ontario Region
25 St. Clair Ave. East
Toronto, Ont,
M4T 1M2

PASUT, M. R.
Suncor
56 Wellesley Street West
Toronto, Ont.
M5S 2S4

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Environmental Approvals
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M4V 1P5

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M4V 1M2

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Regional Municipality of
Waterloo
Marsland Centre
Waterloo, Ont.
N2J 4G7

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Toronto, Ont.
M5S 2S4

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M5S 1Z8

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Thunder Bay, Ont.
P7E 2V6

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Toronto Buttonville Airport
Markham, Ont.
L3P 3J9

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Toronto, Ont.
M5X 1C1

PIZANS, Anthony
TRicil (Sarnia) Ltd.
RR #1
Corunna, Ont.
NON 1GO

PLACEK, Steve
Steve Placek Co. Ltd.
P. O. Box 10, Stn. Z
Toronto, Ont.
M5N 2Z3

PODSIADLO, Richard
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Blainville, Quebec
J7E 4J7

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A1C 5V3

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L8N 3J5

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L4X 2B6

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L5B 2V2

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M4V 1P5

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L5B 2V2

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Markham, Ont.
L3R 2S1

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H1T 3X3

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L4W 2V6

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Canada Cement Lafarge Ltd.
Woodstock, Ontario

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M9W 5L1

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N6A 4L9

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Sudbury, Ont.
P3E 5P9

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M4V 1P5

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Metal Recovery Industries Inc.
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L8H 7N7

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L6J 5E4

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Brampton, Ont.
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The SNC Group
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M5C 2A5

RUPKE, J. W. Gerald
Rupke & Associates Ltd.
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Bradford, Ont.
L3Z 2N8

SAKAMOTO, Ken
M. M. Dillon Limited
Box 426
London, Ont.
M6A 4W7

SALBACH, S. E.
Environment Ont.
1 St. Clair Ave. W.
Toronto, Ont.
M4V 1K6

SANSOM, Tim
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108 Skyway Ave.
Rexdale, Ont.
M9W 4Y9

SAWYER, Bob
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M5G 1Y8

SAX, Dr. Sol
Ontario Hydro
700 University Ave.
Toronto, Ont.
M5G 1X6

SCARSBROOK, P. M.
H. J. Heinz Co. of Canada Ltd.
Erie Street South
Leamington, Ont.
N8H 3W8

SCHTIVELMAN, Anatoli
Monenco Limited
400 Monenco Place
801- 6 Ave. S.W.
Calgary, Alberta
T2P 3W3

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M4V 1P5

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Ontario Waste Management Corp.
2 Bloor Street West
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M4W 3E2

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N5A 6T7

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L5B 2V2

SEIF, FARAD
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M3B 3B2

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M6P 1B6

SERVICE, W. I.
3M Canada Inc.
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N6A 4T1

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Canviro Consultants Ltd.
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N2H 5M5

SHANS, Ronald
Dartmouth College Envs.
Nathan Smith Envs.
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N8Y 4S5

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Uniroyal Chemical
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N3B 3A3

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P. O. Box 681
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Garrett Mfg. Ltd.
255 Attwell Drive
Rexdale, Ont.
M9W 5B8

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P. O. Box 100
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L2V 3V8

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M4V 1P5

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Shell Canada Ltd.
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M5G 1X4

SMITH, J.
Maple Lodge Farms Ltd.
R.R. #2
Norval, Ont.
LOP 1KO

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M5E 1E7

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L3V 6L4

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M4V 1P5

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Axel Johnson Inc.
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H9P 1A3

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L8E 3X8

SOMES, William F.
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N7T 7M2

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U. S. A. 14107

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Armco Inc.
Environmental Engineering
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U.S.A. 45043

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M4V 1P5

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K1A 1C8

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163 Hope Street North
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L1A 2P2

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119 King Street West
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L8N 3Z9

STRETTON, James A.
Alcan Canada Products Ltd.
P. O. Box 2000
Kingston, Ont.
K7L 4Z5

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1 St. Clair Ave. W. 4th Fl.
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M4V 1K6

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L8E 3X8

SZAKOLCAI, Akos
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M5S 1Z8

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95 St. Clair Ave. West
Toronto, Ont.
M4V 1P2

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Regional Municipality of
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L8N 3T4

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M7A 1A2

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M5R 2P4

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K7L 4Z5

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3M Canada Inc.
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N6A 4T1

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Buhler-Miag (Canada) Ltd.
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M3A 2P8

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M2J 4P8

URQUHART, Rick
Kimberly-Clark of Canada
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POA 1KO

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P7C 5G6

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L8N 3J5

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Metcalfe St.
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P7C 5G6

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Acres Consulting Services
5259 Dorchester
Niagara Falls, Ont.
L2E 6W1

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Walker Bros. Quarries Ltd.
Box 100
Thorold, Ont.
L2V 3Y8

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Walker Bros. Quarries Ltd.
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Hamilton, Ont.
L8N 3J5

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M4V 1P5

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Domtar Chemicals Group - W.P.D.
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H9R 3T5

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L5B 2V2

WELBOURN, Rick
C.B.C. Radio News
509 Parliament Street
Toronto, Ont.

WELLS, Wally
M. M. Dillon Ltd.
47 Sheppard Ave. East
North York, Ont.

WHITEHEAD, Dr. Roy
Enviroclean - Maclaren Plansearch
320 Adelaide St. South
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N5Z 3L2

WHITTALL, Ralph
Continental Can Canada Inc.
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M4P 2W8

WIBER, Maxine A.
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L5B 2V2

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RR #1
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NON 1GO

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L8N 3J5

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77 Brown's Line
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M8W 4X9

WILSON, Derek
Derek L. Wilson Ltd.
104 Sheppard Ave. W.
Willowdale, Ont.
M2N 1M5

WILSON, G. E.
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N6A 5L3

WILSON, Roger
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L1A 3V9

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L5H 3E8

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